

# *Creating Origami*

by J.C. Nolan



An exploration into the process of designing paper sculpture

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An exploration into the process of designing paper sculpture

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*This book is lovingly dedicated to my grandmother,  
Jeanada Nolan, for clandestinely encouraging my  
artistic tendencies throughout my entire life.*





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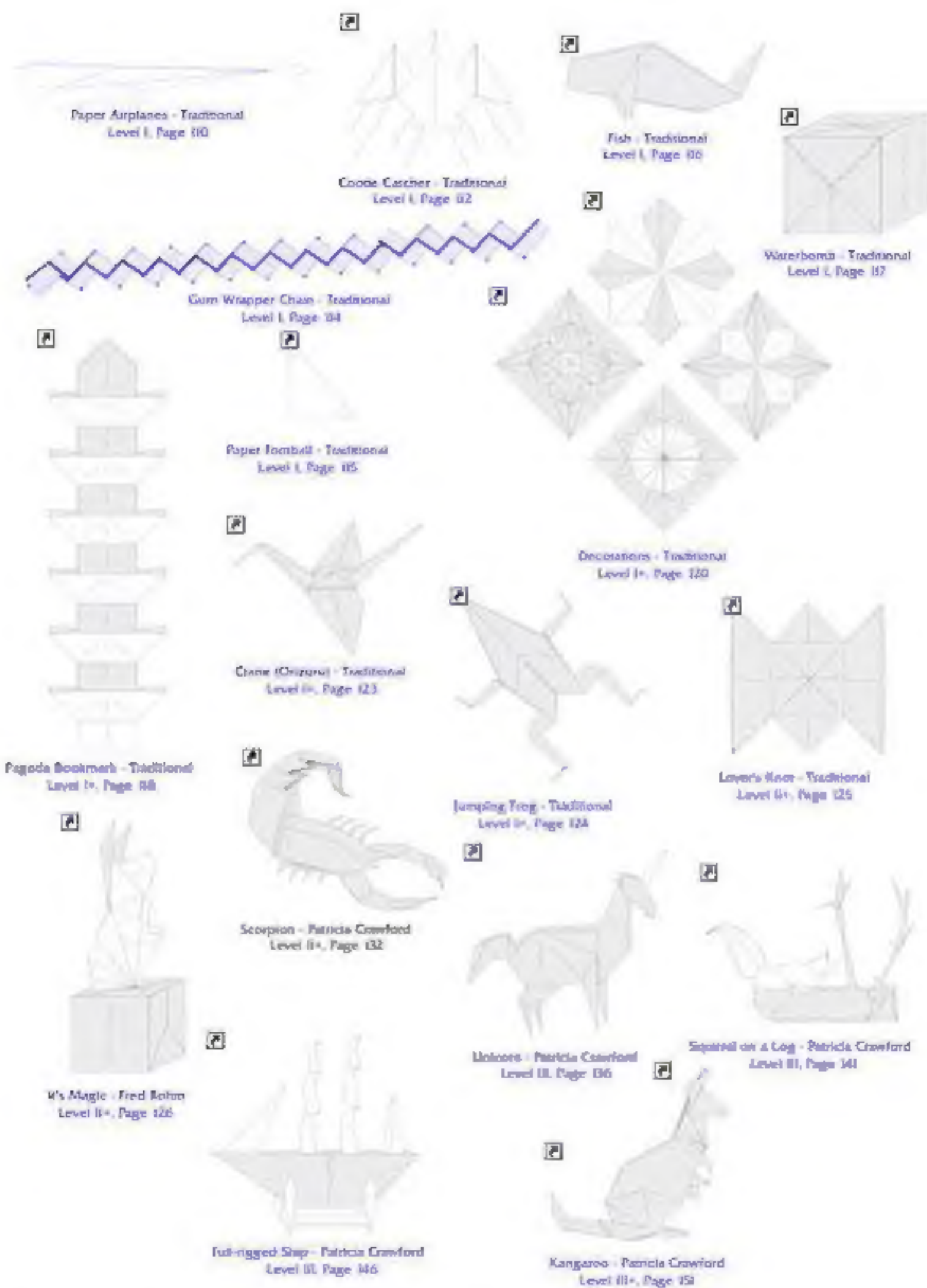
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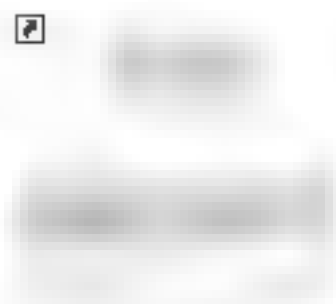
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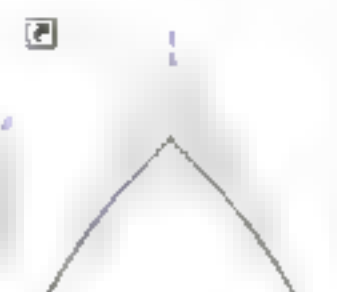
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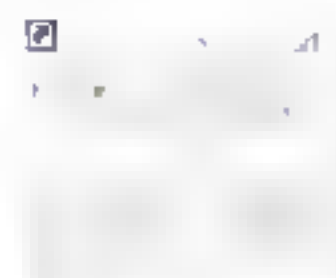
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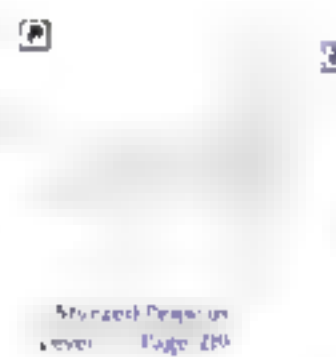
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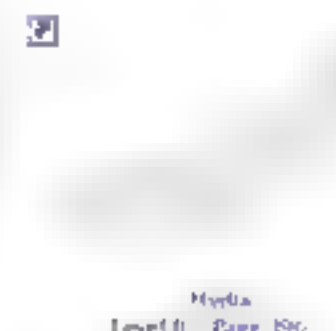
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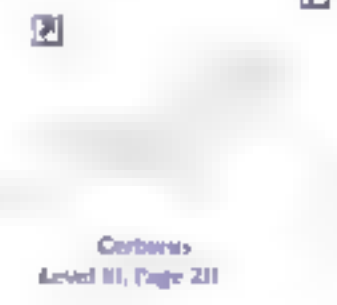
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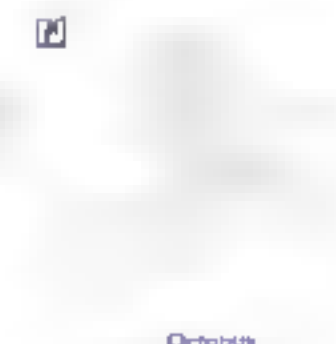
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## About this Book

This book was created under Microsoft Windows in various resolutions. The majority of the work was done on two platforms: a 386 PC and a 486 66. All diagrams were created using Micrographix Designer 3.1. Additional layout work was done using Ventura Publisher 4.0 & 5.0. The fonts used are Zapf Chancery, Palatino and Fritz Quadrata all of which were designed by Herman Zapf.

For more information about origami or to locate books or paper send a self-addressed business sized envelope with two first-class stamps to:

Origami U.S.A.  
15 West 77th St  
New York, NY 10024-5192

## Acknowledgments

*I would like to acknowledge, in no particular order, the people who assisted/inspired me while writing this book*

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*And finally, to my two muses, Snickles and Calliope*

## Forward

Every kid is intrigued by a treasure map. Images of buried fortunes. “X” marks the spot. Secret clues. Everybody who is young at heart is searching for exciting new opportunities. This book is a treasure map, but we don’t know what treasure is buried, and neither do you! We do know where the treasure is buried—inside your mind.

Amazing! “Wonderful!” Wow! “Brilliant!” Every organic designer likes to hear these kinds of words when people encounter their creations. Often the public is not so kind. They may be thinking “I could have done better.” “What clunky legs!” “What a sloppy folder!” Designing or creating is what some people do. Having the part of the critic is what all of us do. Creating new organic can be an exciting endeavor, but showing it to the public opens your soul to the world.

Here is a book about the process of creating wild and wonderful subjects, written for human beings by a human being who doesn’t mind hearing his soul. (One with it.) Sean on his own journey inside his mind, he gives us valuable insight gleaned from his own experiences at creating. He has summarized and explored a wide variety of creative approaches so that you might understand and utilize them to create with greater success.

He has also republished several important organic creations of Crawford and Raher, which are in press of him as a young teacher. A skilled diagrammer, he appreciates organic designs at a different level than most, since few of us draw nearly enough. This skill has given him intimate access to some of the most contemporary designs coming out of this “golden age of organic.” His expert computer graphics skills have made these presentations a valuable addition to every organic creator’s library.

Organic is a puzzle and a challenge. This is one reason why toying is fun. Comparing your designs to those of other people is interesting and enlightening. Even if you aren’t ready to create, coding and learning about coding is also fun, so read this. Consider what he has to say, then cut your own imagination loose and savor the creative experience. It is one of the big things that separates us from the other stuff on the planet!

— Michael LaFosse

## Preface (Read this! No, really...)

I hadn't folded for years—over a decade actually, and suddenly I found myself immersed in it again, exploring new models, experimenting with new techniques and doing things which I had never been able to do in the past. Then, almost by accident, almost on a whim, I created my first original model. I was enraptured with the experience. I wanted to know more about creating, learn what others already knew—the pitfalls, how it was done. What I learned was that not much on the subject existed, and that the people I interviewed did not have much to say either, except that there was not much to be said.

I was disappointed, but still enthusiastic. I decided that if the creation process had never been documented, then I would be the one to do it. I'd create more original models and write about what I learned in the process.

I had no idea what I was getting myself into.

Several years and hundreds of hours of study later, I know more about origami than I ever imagined, and I am also sure that what I know is only a fraction of what has, and has yet to be discovered.

It's difficult to write about the process of creating. It is like discussing how to write poetry, music, or how to sculpt. Describing the methods and tools and techniques is straightforward, but when it comes to talking about where the inspiration for creating a model originates, or how to judge whether or not a model is aesthetically successful, we descend blindly into the realm of philosophy, where concrete answers are often the exception and not the rule.

In this book I relate from my personal point of view, the experiences, observations, insights, and feelings that I had while designing the models contained within. The writing is personal, because that is the nature of the process of creation. The information is both technical and philosophical in content and is presented as essays which are intended to be digested independently, but when considered together, will build upon each other to form a larger whole. Producing this book has been a labor of love, and I hope that it instills in the reader the same enthusiasm for creation that I have savored. Or, if you are not inclined to design, gives an entertaining and intriguing insight into this fledgling art form.





# Introduction

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*"And the first rude sketch that the world had seen was  
joy to his mighty heart, till the Devil whispered from  
behind the leaves, 'It's pretty, but is it art?'"*

*— Rudyard Kipling*

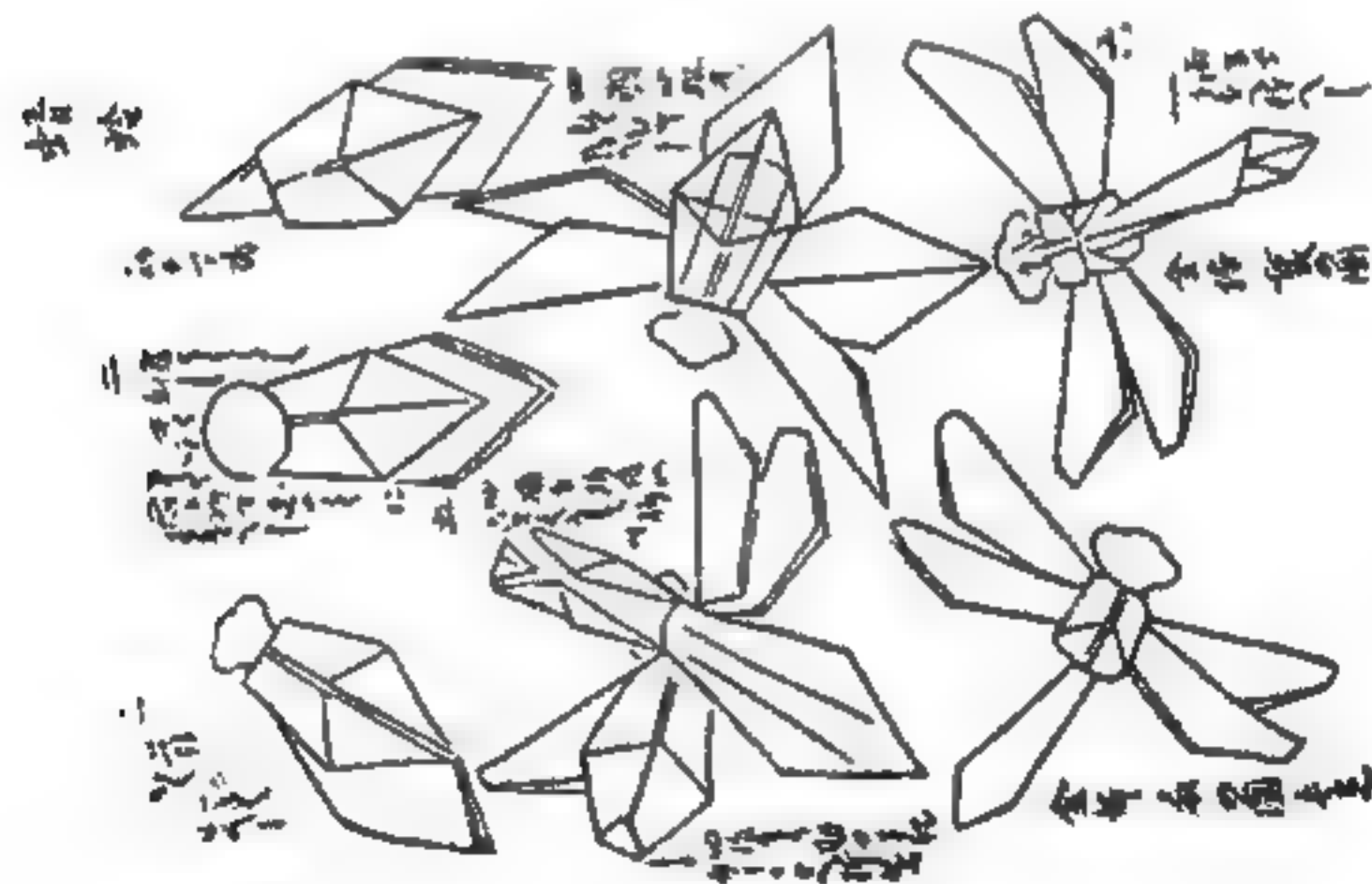


# Introduction

## Creating Origami: The Origin

I started with a dragonfly created many years ago by an unknown Japanese artist. The model came to me through a book from my childhood which I'd lost track of over the years. After a fifteen year hiatus I found myself folding again, and having followed the directions for the dragonfly, was quite dissatisfied with the result. Not only was the model not particularly crisp, but it required numerous cuts and was folded from a hexagon rather than a square. It didn't do much for me aesthetically either.

When I was in my teens, I was interested in learning to program in a computer language called "Assembly" but was told by all my computer buddies, "No one can write in Assembly. You have to be a genius to do that." So, for awhile, sort of lived in fear of Assembly, afraid to even try. Luckily I'm stubborn, and eventually I decided to teach it to myself, regardless of whether I was smart enough to learn it. I discovered that it wasn't hard at all, just very different from other languages. Later when I was in college, I learned that Assembly was a required course for graduation. Obviously if everybody was expected to take the course, it couldn't have been that hard. In fact, there was never any reason to be afraid; it was only my attitude toward it which made it intimidating.

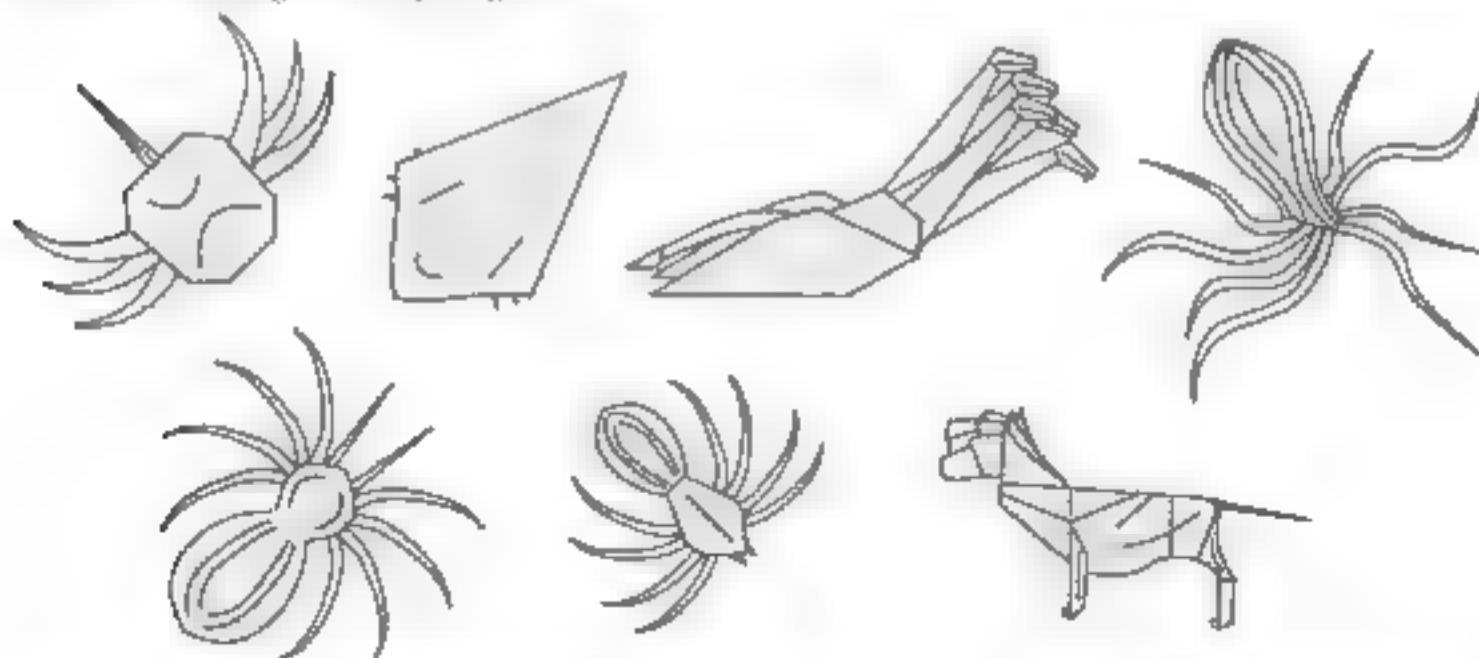


That is not to say that I do not appreciate the model. Historically it is a craft and device as are all the earliest origami creations, regardless of whether or not they adhere to the more modern idea of one square, no cuts. Their designs in terms of effectiveness and stylized beauty are exceptional considering their simplicity. The fact that such intriguing beauty can be produced from a few folds and a single sheet is truly a cause for admiration. But in truth this is Model T's industrial age of high performance, electrically controlled automobiles. The technologies that are now available to creators such as an accepted and standardized notation and several decades of recorded modesty which is a direct inspiration given without advantage to designers who has resulted in designs of such sophistication that would have not been dreamed possible by early creators.

And so it was with origami. It always seemed to me that the creation of origami models was akin to magic invoked by mysterious and hyper-intelligent magicians who gathered in exclusive covens and shared their secrets only among themselves while endlessly producing diagrams and books to be disseminated to the rest of us. I felt that designing was a task far beyond my capabilities, so I never even considered trying. But somehow the dragonfly inspired me, perhaps because I was so displeased with the original, or perhaps it was because I was older and more confident. In any case I found myself thinking I could find a way to fold it without cutting. And off I went.

I wish I could say that creating a dragonfly was a simple task. It was in fact a process that took several months in which I encountered many stumbling blocks. But from my design attempts I inadvertently created a multitude of other models including a horseshoe crab, a spider, a tarantula, an octopus, a strange leaf-like insect and an eight-sided birdhouse.<sup>1</sup> These other models were discovered partly by accident and partly through experimentation while trying to overcome problems I encountered in designing the dragonfly. The horseshoe crab was folded first, while doodling around with a piece of paper in attempting to create a base for the dragonfly. The wolf spider and eight-sided birdhouse were created while experimenting with the dragonfly's wings. The tarantula and octopus were discovered while trying to adjust some of the proportions of the wolf spider and the leaf bug, a creature I actually practiced making before I had an idea that it had for the dragonfly's legs. Each of the models was created in one form or another from a dragonfly, though I came upon most of them by accident.

This period of discovery was an enormous growing experience for me, and I was extremely excited by the process. I wanted to learn everything there was to know about designing that I could. I wanted to know how creators kept track of their models as they folded without instructions and how they solved the problems they encountered in their designs. I wanted to know where their inspiration came from and what styles they utilized. I wanted to know how people create. But after interviewing several designers of origami models including Michael Small at the Friends of the Origami Center of America and John Montroll, what I learned was that little had been written on the subject. I decided that if there were no books available then I would write my own, and thus started a three-year project of observation, frustration and jubilation. Creating "Creating Origami."



<sup>1</sup> Which I later used in another model of Cerberus, a mythological, three-headed dog.

<sup>2</sup> I think that the lack of published information is responsible for my own use of mysticism regarding the creation of a model. It is also worth mentioning that origami has been growing greatly in popularity as the past several years and as interest in the art form spreads, books on the topic will become more common. There are a number of several excellent books that contain sections on creating, though in some cases these are not necessarily technical and difficult to approach. These are: "Origami: The Art of Japanese Paper" by the great Japanese master Kashiwa Kashiwa, "Folding the Universe" by Peter Engel and "Origami Zoo" by Robert Lang and Stephen Weiss.

## Creating Origami: Philosophy

Over the past decades origami has grown in acceptance and popularity. While historically it has been viewed as an enjoyable and intriguing activity to be shared by both the young and the young at heart, it is in fact a fledgling art form that is just now beginning to reach recognition. A similar sort of transformation has been seen recently in the realm of comic books. Traditionally comics have been viewed as "pulp fiction" consisting of mindless stories with shallow characterizations and thematically empty plot lines. But over the last decade there has been a movement by artists such as Frank Miller, Alan Moore & Dave Simm to create comics of literary and artistic merit. This led to early significant works such as "Kunin", "Dark Knight", "The Watchmen" and "Cerebus". Each of these works is literally a novel presented in graphic form. The success of these initial efforts led to an increase in the production of comics of greater substance which led to more and more artists jumping on the comics bandwagon. This change in perspective is the primary cause of the enormous proliferation of comic book-related material that can be seen on the television and cinematic media in the past several years, not to mention a maturation of thematic content of the story lines found in mainstream comic books such as "Spiderman" and "Superman".

And so it is with paper folding. While previously it was considered by most to be a hobby like needlepoint or model rocketry where following the directions and completing the project was half the triumph, there is a growing perception of origami as a form of sculpture where the objective is to create sculptural forms under extreme limitations—produced by simply folding a square piece of paper.

Historically there have been many forms of art where such severe limitations are imposed. The Shakespeare canon, for example, is a poem with exactly fourteen lines of text which are grouped in quatrains—sets of four lines and are followed by one set or two. It must have a specific rhyme to it meaning that all accents on words must have a specific pattern. Additionally, the first line must be rhymed with the third, the second with the fourth and so on.<sup>1</sup> Classical Western music, simple forms can also be argued. One example is the "Canon" where a line of music is played on the first and by one hand, while the other hand plays the same line, just out of synchronization with the first.<sup>2</sup> The "Crab Canon" is another example where one hand of music is played with one hand while the same line is simultaneously played in reverse by the other.<sup>3</sup> As difficult as these canonical forms are to play, they are significantly harder to construct. Not only must each note on each line work well with the others surrounding it, they must also work pleasing with the same one being played backwards or out of synchronization with the first. Avoiding dissonance under these circumstances is a formidable task.

Origami is a form of sculptural sonata in paper. It is a puzzle and engineering achievement as well as an artistic form. It is an intriguing juxtaposition of science and art, of right brain and left, for much of the artistic process is hidden inside the model within the techniques and solutions which were utilized by the designer to produce the actual folding sequence. For the artist whose objective is to create an object of beauty, a great deal of variability in the final result can be derived through choice of media and folding technique, but only by designing original models can they gain complete control over the work. Fortunately, the process of solving problems, overcoming pitfalls, and finally producing a successful result is one of the most satisfying experiences that can be had. Also in this way, the artist has an opportunity to experience every aspect of the creative process, not only the choice of media and folding technique, but the joy of creation, the ability to control every minute aspect of the final product.

1. The song "Row, Row, Row Your Boat" is a well known example of a common canon.

Fast moving descriptions of these as well as other canonical forms can be found in the book "Crabbed Fiches: Back to Douglas

R. Hirschman.

## Creating Origami: The Structure

This book has three major sections: "Experimentations," "Inspirations," & "Creations." The last two contain directions for folding actual models and a short description of the origins of each model. "Inspirations" contains models which I found the most intriguing in my youth. Some were my favorites to fold and others were models which I dreamed of folding but could never decipher. Many of these models, particularly those by Akira Crawford, are no longer available in print. Others, like the "gum wrapper chain," have never seen published. The next section, "Creations," includes instructions for folding the models I designed while producing this book. Some of the models are crude and others more refined. Some are simple and others extremely complex. I believe that it is important to show all of my work, not only my best, but also those which are perhaps not as polished or satisfying to me, because the creation of each model, regardless of how successful the result, was an important learning experience.

"Experimentations" is dedicated to discussing the process of designing origami and relating what I learned while creating the models in this book. It is broken up into several subsections. The first is devoted to discussing the tools and materials which are so important to the creation process. The second gives an historic representation of how each of my models was created. I discuss the approach that I used in creating the model, where the original idea came from, as well as what problems I had to overcome during my design process. The last subsection of "Experimentations" addresses on a theoretical level, the process of creation, and includes various essays on other topics pertinent to the subject.

I hope you enjoy "Creating Origami." Producing it has been an enormous growing experience to me. In developing it, I have gained a great respect for the designers that came before me and for those who are still designing today. Sir Isaac Newton said "If I have seen further it is because I have stood on the shoulders of giants," and that is very much how I feel with regard to my own work. Developing origami models is in many ways, as with other art forms, a process where discoveries are made by studying the work of others and gaining inspiration from them, or taking the inventions of others and analyzing them in new ways, and or taking the work of another and modifying it until it becomes something different and uniquely your own. I hope that this book inspires you to do just that, with my work and with the work of others, and that you will share in the excitement and satisfaction that comes with designing your own original origami creations.







# Experimentations

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*"I don't give these lectures to surprise people,  
but out of a need for poetry" — John Cage*



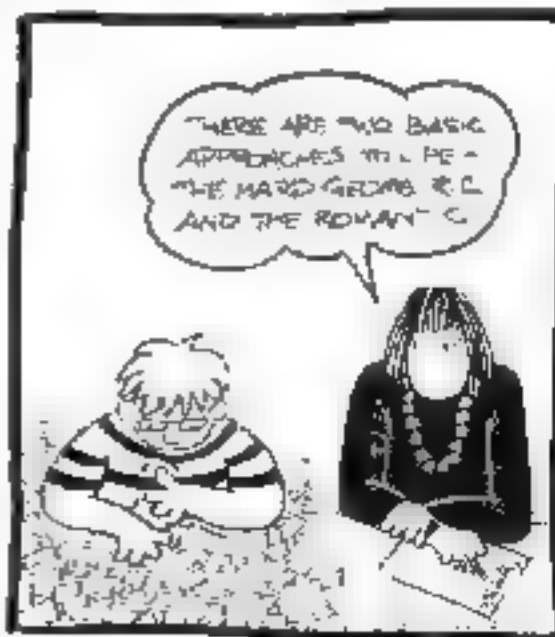
# Creating

## The Challenge -

When you first embark into the realm of design you are faced with an intimidating array of questions. How does one go about designing original models? What is the proper approach? How do you go from an idea to a completed piece? How do you avoid pitfalls and overcome the obstacles that you encounter? How in the world do you keep track of where you have been so that you can reproduce your work? From which bases is it best to start? Should you work on existing models or try to create something completely unique? With all the astonishing models already in existence is there any hope of creating something worthwhile? These and other very important questions will permeate your mind as you start to explore. And as you proceed you will find that there are no concrete answers, but that rather these issues will resolve themselves as you gain experience. Most important is being willing to allow yourself the space to learn and create, remembering that each individual is unique, and has something different to bring to the art form, whether it be a fantastic new approach for telling a fully functional grandfather clock that keeps accurate time, or simply a new twist on the traditional crane.

## EDGEWISE

by Kathleen O'Regan



If there is a single piece of advice that I would want to give to the novice creator it is to be extremely gentle with yourself. Designing can be extremely challenging because it requires the creator to function in two roles simultaneously as an artist and as an engineer. Much more goes into an origami model than can be seen in the completed piece. It is a process of both artistic vision and logical analysis where the creator must not only be concerned with the appearance of the completed model but must also make strategic decisions in how to proceed with the construction of the piece. For while the outward aesthetic appearance of the model is obviously important of equal importance is the internal design, the structural approach chosen in creating the piece. This duality poses an intriguing challenge because creative and analytical ability are controlled by different portions of the brain. Psychologists have learned that aesthetic and creative functions are controlled by the right half of the brain while analytical and computational functions are handled by the left. In most individuals one side of the brain has dominance over the other. Depending on which side of the brain is dominant people tend to be more comfortable with one type of task creative or logical. Specifically right-brain dominant persons tend to be more comfortable with creative tasks such as working with people or artistic design, while left-brain dominant individuals are more comfortable with analytical tasks such as mathematics and engineering. It is this natural tendency which makes origami significantly difficult because it is a whole-brain activity where both the creative and analytical portions of the brain must be utilized simultaneously for when designing the creator must address both artistic and technical issues not only how the model will appear artistic but how to get there in the first place technical. Fortunately like playing a musical instrument learning to draw or studying arithmetic both the artistic and technical aspects of origami design are skills which can be learned, and with practice can be approached by everyone, regardless of talent or aptitude.<sup>1</sup>

Since in all likelihood your own inclination is towards one type of activity over the other when first embarking into origami design I recommend that you concentrate primarily on one side of the situation. If your inclination is towards the artistic and creative allow yourself to get caught up in the aesthetic aspects of the design process. Experiment extensively with the different available mediums and techniques available to you. Start with an existing model or base and play with the paper. Modify scale aspects of existing models to get a sense of what is possible. Try varying the size of the model or the type of base or fold. Change the shape or position or locations of the piece. Change a model of a square into a circle. Turn a circle into a triangle. As you become more comfortable with manipulating existing models and start to get a sense of what is technically possible you will begin to have "ideas" for original projects and will have naturally begun attempting to find ways of implementing them on your own. This will naturally lead you from the artistic side into the technical aspects of creation.

On the other hand, art is not your strength start off by exploring the technical side. Study existing models and try to get a sense of how they are structured. Explain the techniques and approaches of established designers and see if you can't apply them to other models to modify them in a way that you like. Don't concern yourself too much with the appearance of your work but instead concentrate on understanding how the model is formed. As you gain experience it is likely that you will come up with a model of your own that you would like to attempt and will find yourself trying to design a structure with the proper number of points in the proper length and location. Before you know it you will be creating your own designs. Eventually after creating a few or many models you will become more comfortable with the technical side and start to become more concerned with the aesthetic aspects of your work. You will notice that you prefer the appearance of some of your models over others and that you find the work of particular creators more esthetically intriguing than others. This is a natural evolution of your visual sense and will lead to your developing your own aesthetic styles and techniques.

Regardless of your approach be easy on yourself. Doing things which don't come naturally can be extremely intimidating. Designing forces you to look at the folding process in an entirely different way and there are many new skills and techniques which must be applied. Acquiring those skills is a gradual process

<sup>1</sup> There are individuals who are whole-brain dominant who are equally comfortable with both types of tasks. But these individuals are the exceptions to the rule.

## 4 - Experimentations

and you must be willing to allow yourself the time it takes to learn them. If you pressure yourself to learn faster than your own natural pace you may stress yourself so much that you cannot learn at all. Embrace the design process and take your time. The rate that you are progressing is the rate at which you were meant to progress. Don't pressure yourself to complete models faster than they want to be completed. Some will come easily and some will take months. It's all part of the problem-solving process. Don't struggle with it just let it take place. Don't berate yourself for uncompleted models and puzzles. Let you fail to solve. Every project is a learning experience and even miserable failures are valuable even if only to teach you a new and original way not to do something. Every minute you spend on a project brings you one minute closer to completion. Keep working at it, the solution that you are looking for may be just around the corner.<sup>1</sup> Play with your paper unabashedly, and do not judge your work, allow it to flow, unhampered and loved. In doing so you create an environment rich for discovery, growth and inspiration. As you practice your skill and experience will increase and you will gain the confidence that comes with it. "Every journey begins with a single step."<sup>2</sup>

## EDGEWISE

by Kathleen O'Regan



<sup>1</sup> Thomas Edison, the inventor of the incandescent light bulb, spent many years creating what many consider his masterpiece, but he never proved successful. On his history of failure he was reported to have said "I have not failed to create the incandescent light, but rather have discovered over 5000 ways not to make one."  
Lau Tzu



Another obstacle that you will encounter as a designer is learning to retain objectivity from your work. When artists work, concentrating intensely on a piece, sculpting it in the proper direction and trying to overcome the problems that they encounter, a natural intimacy with their work develops which can be hard to escape. In fact, in some ways, I can be impossible to look at your work in the same way that others will, for when you're you will not see a completed product, but will instead perceive all the problems that you overcame during its design and all the problems that still exist.<sup>1</sup> But those who have not been so close will see it differently. When they look upon your work they will see it as a completed project, rather than as the result of a process, and on that level it might be just wonderful, despite its flaws. I once believed that artists can never truly complete a work, but rather reach a point at which they are compelled to cease. At that time, I found it very possible to work and work and work on a piece, with no vision of ever reaching completion. There always seemed to be room for improvements. Of course at some point the process must end, so rather than reaching the point where I truly felt that the work was complete, I would instead simply declare the piece finished, for better or for worse, and acknowledge that I had now learned enough from that success, or even, at failure. Without this artificial forcing of closure, I would have driven myself insane, attempting to improve my work indefinitely. Now that I have matured, it should I say, or I hope, I see things differently. It is now clear to me that for the artist, the artistic experience is less about the completed work than it is about the process of creation, for there is so much more to be gained and learned by going through the experience of creation than can ever be observed in the completed work. Having gained this understanding, it becomes much easier to step back from your work, seeing it as simply the result or effect of the process, rather than the process itself. And regardless of the perceived success in the completed product, there is always value in the process. This does not mean that you will not return to the work at a later point and try to make it further, perhaps improving it or evolving it in the direction. But to see that for now you have taken from the experience all that you want, but only to free your mind of its rigidity, but also allows you to take a lot of pressure off yourself. Coming to this point is a very important part of developing as an artist.

at a similar vein, you must also avoid being overly critical of yourself. As a designer it is likely that you will take on the traditional role of your own greatest critic. This is appropriate, but at some point you need some slack. As in trying your idea in comparison to others. All creators are unique, regardless of the experience or skill level, and bring to their art forms something special to their own viewpoint, their own personality, their own philosophy. It can be beneficial to look to other creators for inspiration, to their artistic style, to their ingenuity, to their creativity or productivity, but not if doing so serves to impede your progress. Never look at the work of others and say, "I couldn't do that, it's too sophisticated, it's too elegant." No matter how good you are, it is almost certain that somehow, somewhere, someone is better. If novice creators will to compare their work with the sophistication of Lang, or the artistry of Yoshizawa, or the practicalness of Mayrtrull, of course they would come up short. Those individuals have been creating for years, and have quite a head start. This does not mean that you cannot aspire to reach that level. Perhaps someday you will reach, or surpass them, but that really doesn't matter. What is important is to enjoy what you are doing, judge your work in terms of where you have come from and what you have learned, not in terms of what you have yet to accomplish. Give yourself the time to learn, and perhaps some day an aspiring creator will be looking to you for inspiration. Most important for the aspiring creator is to remember to give yourself lots of space and time to learn and allow yourself to enjoy the process. Each new experience is precious, whether perceived as successful or unsuccessful, for there is a lot to learn as you proceed and in many ways the creation process itself is more valuable than the completed product. Perhaps some day you will reach your highest goal, but more important is that the experience be enriching and enjoyable for you.

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1. For example, the legs that are slightly too long or the area at the rear that is still a little too thick.

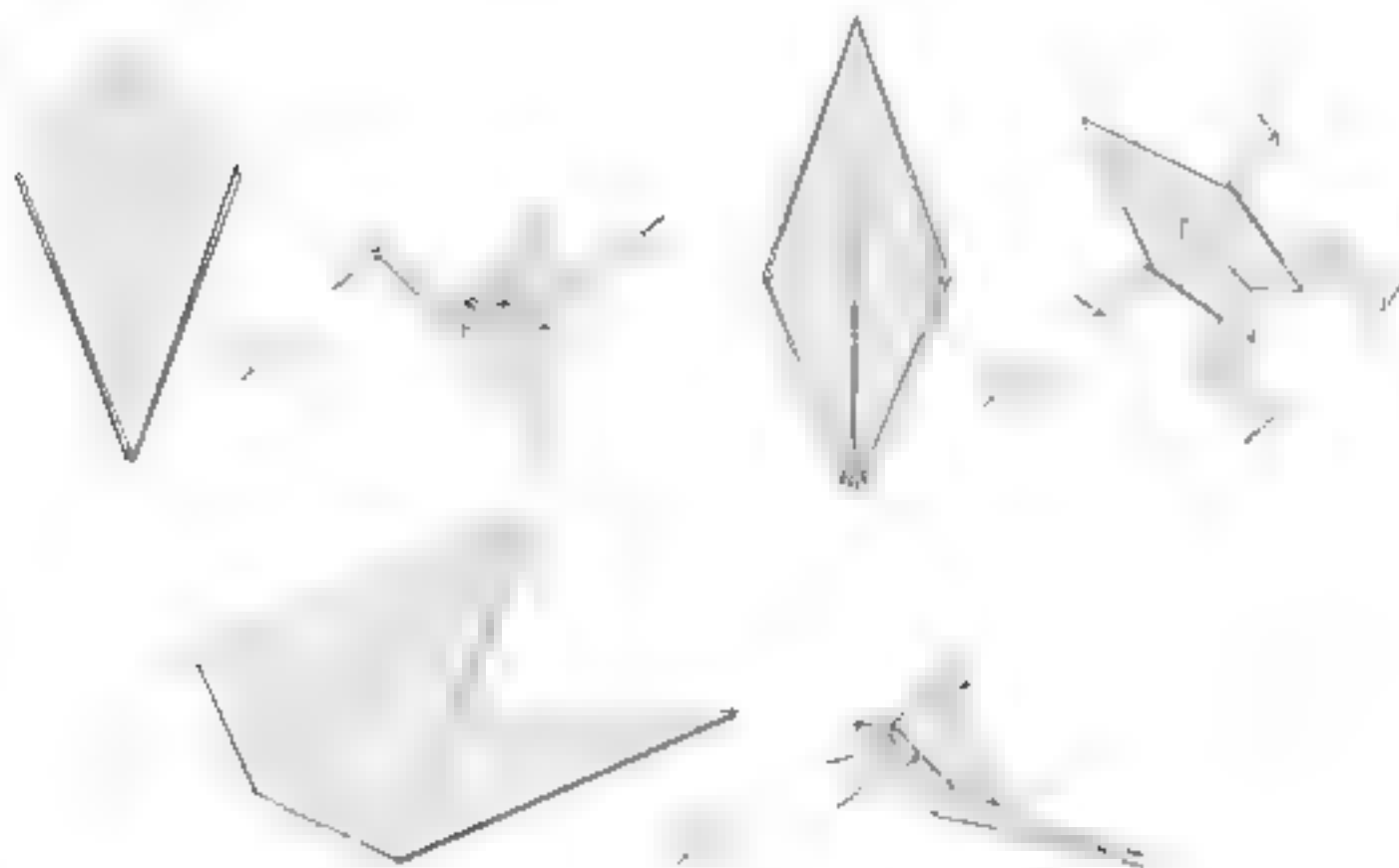
## Approaches to Creating -

So, the obvious question is - How does one approach designing? Just how do you create original? In actuality there are as many ways of creating origami as there are creators. For as artists bring to the art form their own personal vision and aesthetic style, they also bring their own unique approach to design. Some are extremely technical and depend upon knowledge of math and engineering in designing. Some creators are more intuitive in their approach and prefer to simply play around with the paper until something interesting happens. There are those who are more philosophical in their approach, and search for the "soul" of their model as they are creating, and there are other creators whose approach to creation is so elusive that there is little that one can do to describe it. In actuality, most creators use a diverse array of approaches, and depending on the model on which they are working, will rely more heavily upon one approach than another, utilizing the one that seems easiest for that particular subject.

No matter which approach you choose, if you are a beginner the most important thing for you to do is to expose yourself to as many different creators and models as possible. Fill your arsenal with as diverse an array of skills as you can. In doing so you will not only hone your folding skills, but you will be introduced to differing aesthetic styles and approaches to design. This is advantageous because the more you are exposed to, the more you will have to draw upon when designing. For example, you might come upon a model wherein the creator uses a common technique in an unusual way, and find that the technique is exactly what you need to overcome a stumbling block in one of your own designs. Additionally, you might discover a new use from which to explore, or get an idea for a new model, or learn a new technique of which you were previously unaware. Fold everything that you can and attempt it as much as you can go will allow. The broader your range of experience the better prepared you will be when designing on your own. And, advice practice practice. Like drawing portraits or playing a musical instrument, origami is a fine skill that improves with practice. Once one is exposed to the fundamental techniques, such as drawing a line straight, assessing proper proportions, or counting, reading maps and proper folding, one must improve one's skills through repetition and exposing themselves to as diverse array of subjects as possible. With each attempt there is an opportunity to learn something new or improve upon that which has been done before. It is only through this practice that one becomes an accomplished artist. I don't only become an issue with regard to how quickly the skill might be mastered or if what the artist can do with these skills once they have achieved mastery. Allow yourself the time to master these techniques so that you can then allow your talents to show. You must first walk before you can learn to run.

But - diverge. Back to the question at hand - how does one go about designing original models? As mentioned previously, there are many different ways of approaching the design process, but they all have a fundamental commonality. I first came upon an understanding of this fundamental approach when I first folded the Art Deco Lily. In this case I had been talking to a friend about the squash folds that were used in the spider bases. He has no interest in origami, but being an technical engineer, is intrigued by the processes used in paper folding. The spider base starts with a waterbomb base, which has had each of its four flaps squash folded. I demonstrated this and handed him the result. Over the course of the next few minutes he proceeded to squash each of the resulting eight flaps and gave the model back to me. I looked at the squashed form and immediately saw in it a flower and quickly proceeded to complete the model. I recognized in that moment of insight the central magic of origami design, the ability to take an abstract shape and see in it a completed subject. To my friend, the form that he was handing to me was little more than a piece of paper which had been reduced into sixteen flaps, but to me, it was a base for a flower. Therein lies the fundamental approach to designing origami, to create an abstract form, or base, from which something interesting might be formed. In this way, origami is similar to other forms of sculpture which are subtractive in nature, wherein the shape of the original material has a great deal of impact on the final appearance of the model. For example, if one were carving in wood and started with a log that looks like an alligator, then the sculptor might see an alligator in the wood. Similarly, carving in stone, the artist might see a particular shape in the original material and proceed to free the sculpture hidden within. Identical approaches are taken in origami, moving from a fundamental form to a completed piece.

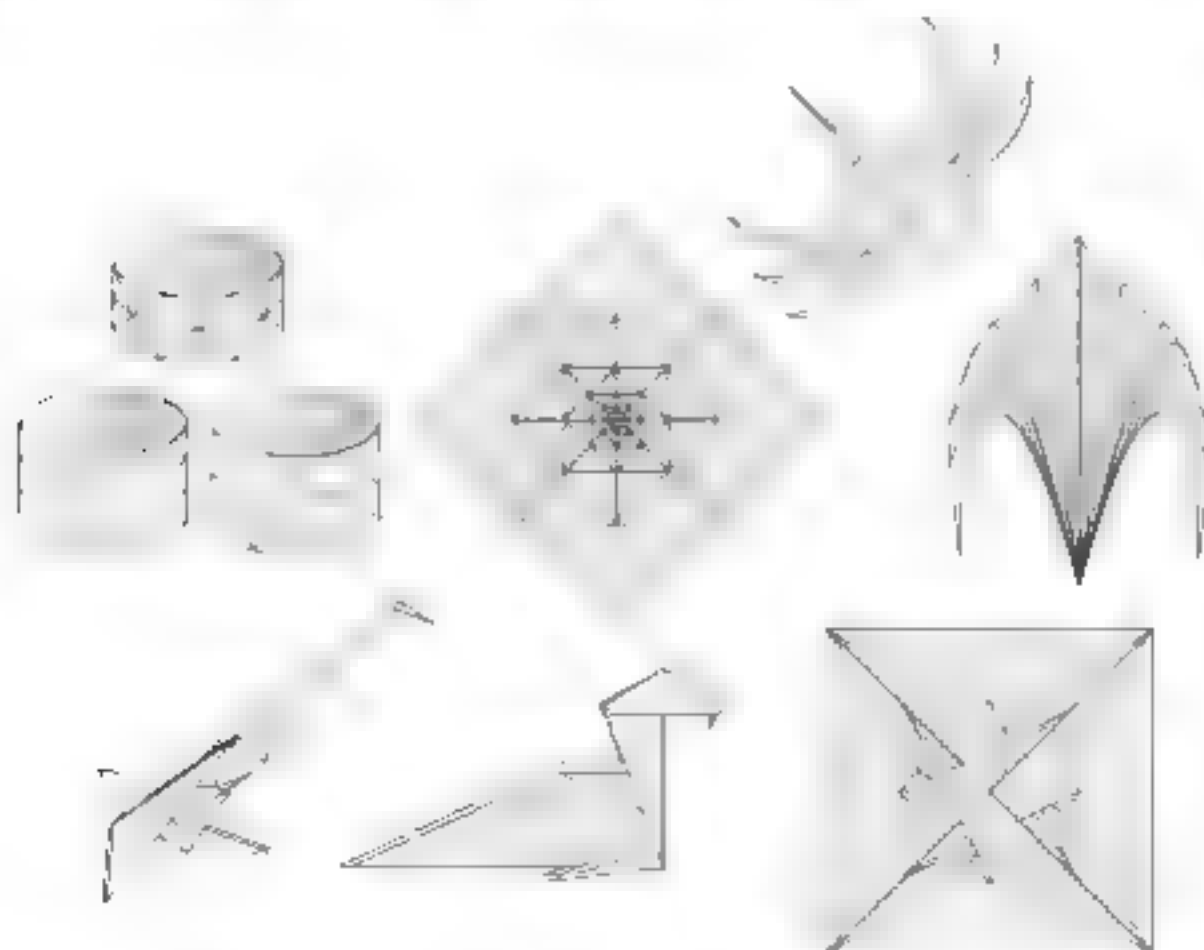
How one goes about creating such a form is altogether a different matter. If the object is to create an interesting or appropriate base from which to sculpt a model, the question then becomes how does one approach creating an interesting base from which to work? As mentioned before, there are numerous methods. They vary greatly in their level of difficulty as well as how much control the designer has over the eventual outcome. Some are less stressful to implement than others, but the more daunting approaches are more likely to get you to a desired destination. Depending upon your intentions and temperament you will most likely use a combination of these methods.



**Accidental** Some models are discovered completely by accident when designing a model was not the creator's intention at all. The Seven Simple Bracclets, the Art Deco Lily, Horseshoe Crab, Andrea's Rose, Colored covers knots, Loch Ness Monster, Taarakian Dragon, and Fairy were all created in this way, to one degree or another. This is, as one might expect, the easiest way to invent a model. One approaches to design, it is by, at the least, intimidating, but it is also the least directed. Notice that models created using this approach tend to be simpler in structure, this is natural because very little "intentional" thought goes into their creation.

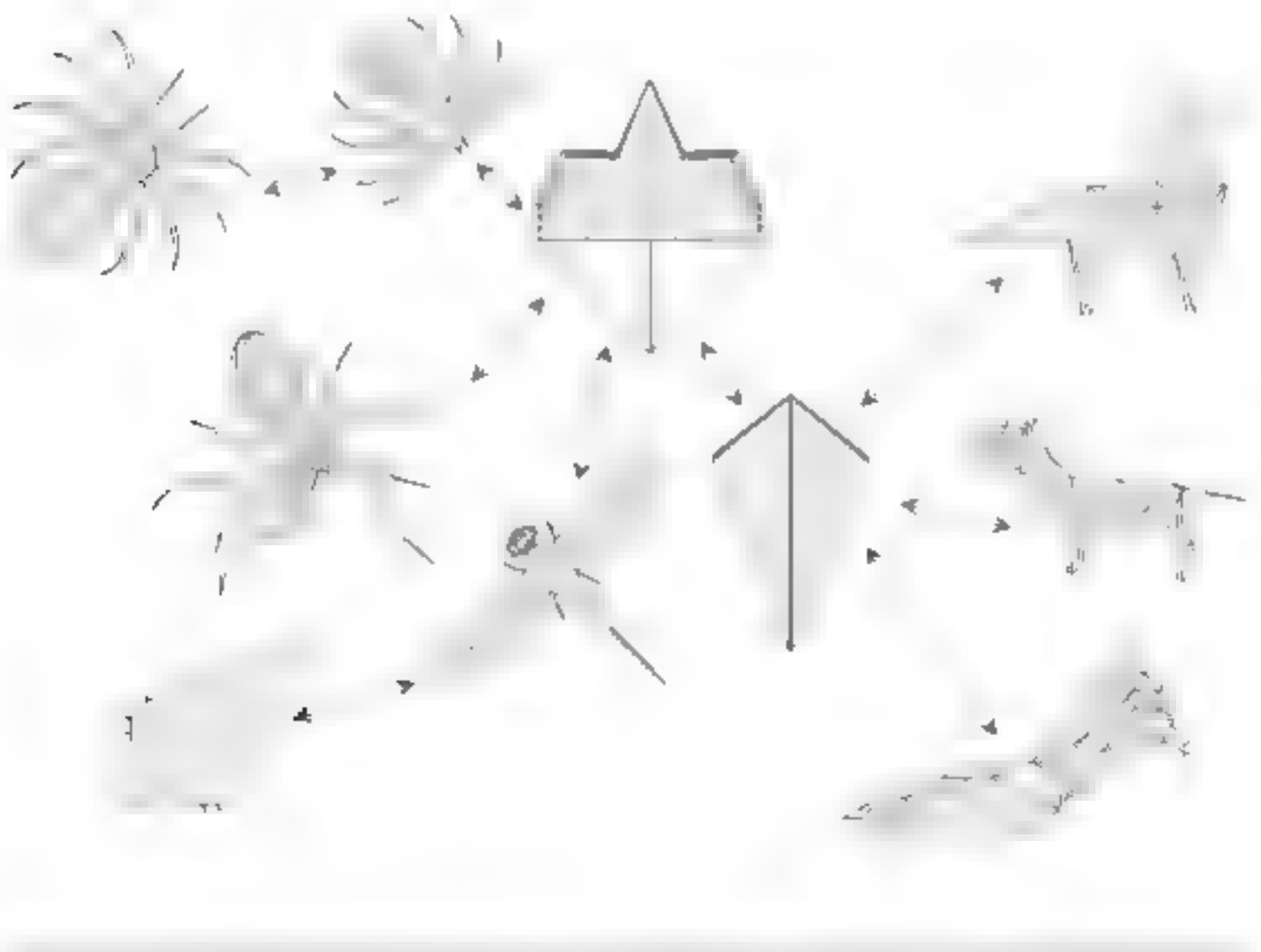
There are several ways for the creator to come upon a model accidentally. For example, while folding an already existing model they might notice that the paper reminds them of something other than the expected result. They might then, rather than completing the work, choose to proceed in a different direction and turn the model into something completely new. Once while teaching my Fairy, one student excitedly informed me that they saw a sea turtle within the model and proceeded to describe to me how it could be modified to allow it to be sculpted into that form. To be honest, I really didn't see it. But that's precisely the kind of insight from which new models are invented. What appeared to me to be a fairy might easily appear to another to be a turtle. For each individual brings to their work a new set of experiences and points of view. A second type of accidental creation can occur as a byproduct of making an error while folding. For upon finding yourself lost you might notice something new and intriguing in the paper and, rather than backing up to correct your mistake, proceed to sculpt the model into something original. One designer informed me that many of his best models were created this way.

Another activity which is a good generator of accidental models is doodling. In doodling you start with a fresh piece of paper or an existing base and simply start experimenting, letting the paper go in whatever direction it chooses, just to see what happens. Often, nothing will, but occasionally, the experiment will lead to a new discovery. John Muntrill is a prolific doodler who creates many of his models in this manner. I once watched him design a wonderful model of a lioness in a matter of minutes while playing around with one of his existing bases and applying his various techniques. Clearly, years of experience gives him an advantage to this type of activity in that he has a huge array of procedures and techniques available to him. But that experience tends only to affect the sophistication and complexity of the models designed. Beginners of all levels can use this approach regardless of their level of experience.



**Serendipitous** This method is a close cousin to accidental creation, but different enough to be considered a unique approach. Serendipity is defined as "an apparent aptitude for making fortunate discoveries accidentally" and so serendipitous creation refers to coming upon a model accidentally while attempting to design another. The difference between this and accidental creation lies in the original intention of the designer. For in accidental creation a model is created while folding an existing model or while drawing, wherein the inventor's intention was not to create a specific model. In serendipitous creation it is the inventor's intention to design a model, but not the one that resulted. When models are created serendipitously they generally come with very little effort and are fully detailed, requiring little work to complete. These models tend to be somewhat more complex than accidental models because the creator was deliberately attempting to design something when they were created.

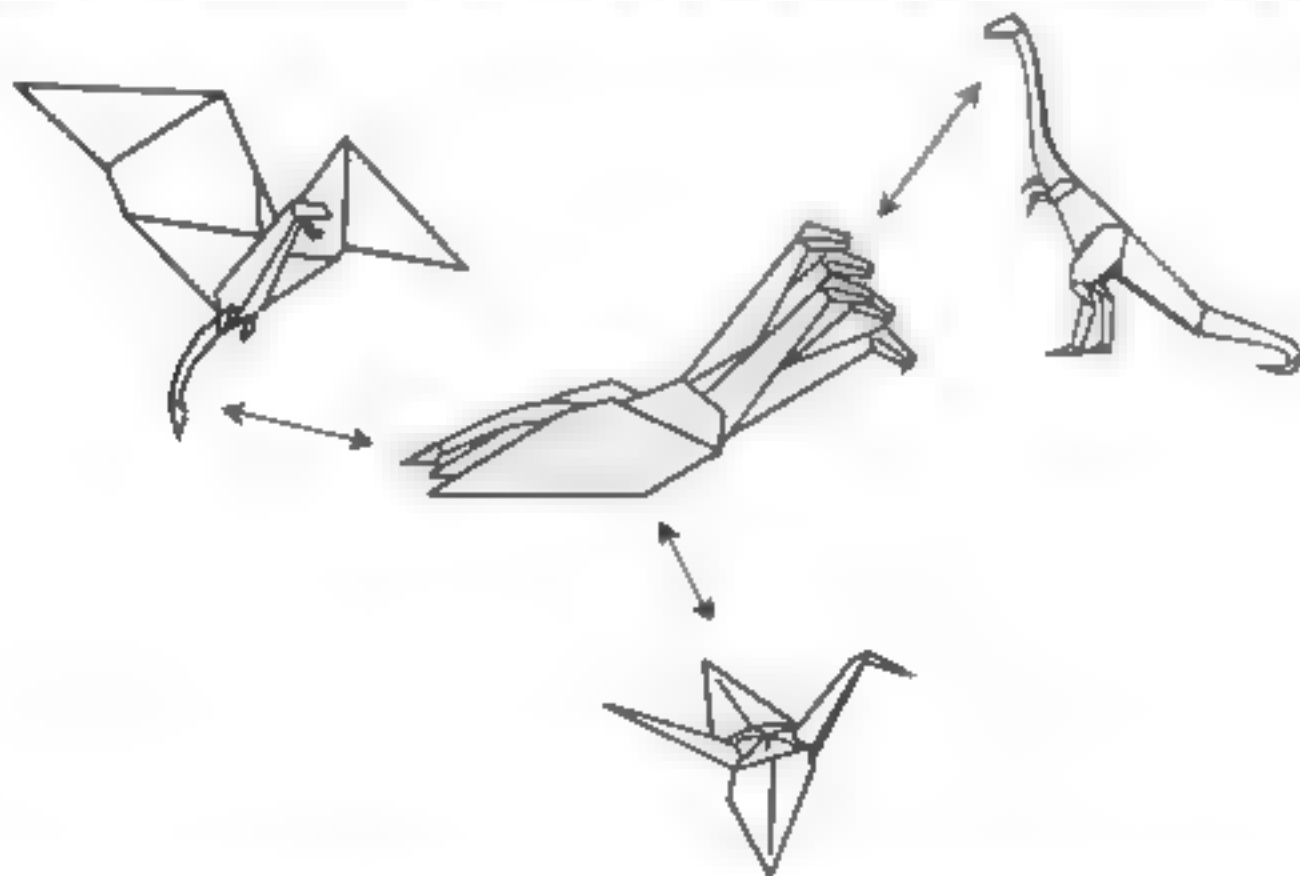
Many of my early models were created serendipitously while I was trying to design the dragonfly. In my attempts I first came upon the spider bases and the double petal fold technique. These are versatile structures which naturally led to the serendipitous discovery of other models. For example, while working on the model I discovered a method of creating an eight flapped bird base from which I was able to create the original versions of Cerberus, the Hydra and Pegasus. I also came upon the Wolf Spider and Tarantula as well as the Octopus. These pieces are all very similar structurally as well as in their folding approach. This is common in serendipitous creations because the models are based on the same initial folding processes. Other models in this book which were created serendipitously are "A simple Dragon for Natasha" which is a one headed flyer, The "Australian Leaf Bug" which was a test model for the dragonfly wings and Body of Paper which was created while trying to integrate the Frost Dragon's Head with the rest of the model.



1 Which is structurally identical to the Tarantula, except that it has eight appendages rather than ten.

**Algorithmic** In this approach, you start with a particular model in mind and create it in a straightforward manner using already existing algorithms. My Hydra is one example of this type of model. I started with an eight-sided bird base which I had created on my own from which I wanted to create a hydra. I knew that it would be easy to create a five-headed version by simply following the regular steps for the crane. But in the case of the Hydra I wanted to make the model more dragon-like, so I borrowed from other models. I took the head created by John Montroll and used in his *Strathmimus* and borrowed the tail from his *Rhamphorynchus*.<sup>1</sup> I also made some strategic modifications in the basic treatment of the bird base using sinks instead of reverse folds to allow the wings to swing backward, but basically the model is based entirely upon algorithms created by others.

One might argue that this approach is akin to plagiarism, but I disagree. Origami like any art form or science which is technologically based and requires the designer to come up with new ways of doing things and original ways of overcoming problems will necessitate basing situations on the work of others. Clearly there is no trademark on the petal fold, or the double rabbit ear, yet both of these techniques are used quite commonly. But it makes sense to assume that at some point in history someone—or several someones—came up with these procedures on their own. Are we then to say that they should not be used because they are not your own unique creations? Absolutely not. The trick to innovating is either coming up with something entirely new, or coming up with a different and original way of combining that which others have done before. In this way your product becomes uniquely yours, or at least a leap effort between you and those from whom you are borrowing the algorithm. I've might deny more satisfaction from a model from which you have worked out the details on your own. But creating details such as ears and tails can be a very intimidating process, and for the beginner it makes a great deal of sense to study and utilize the work of others.<sup>2</sup> As you become more comfortable with the design process it is likely that you will resist using the work of others as a jumping point and desire to create models which are entirely yours. In any case, what is important is that you do create, using any means necessary, for the more experience you acquire, the better prepared you will be to solve the next problem that comes around.



- 1. Which I consider to be one of the best origami dragons I've seen.
- 2. As long as you are sure to give credit to the original designer and acknowledge where you got the approach or idea.

**Inspired** This approach refers to models which come to the creator from "out of the blue." Models designed this way generally come to the creator completed or nearly completed, and are finished with little effort. Sometimes the model comes in the form of a dream, other times the idea comes as an insight while doing something unrelated to organic. Much of Patricia Crawford's work was created in this way. She is reported to have said that her unicorn "Came to her one night in a dream, in its entirety" and that many other models came to her in a similar fashion—either in part or entirety. Peter Engel describes a similar occurrence in this book. Folding the Universe, with regard to the design of his Rattlesnake. In fact, most established designers have some sort of story of a model which simply "folded itself." Models in this book which were created partially or completely using this approach include the Butterfly Chain, Diving Duck, Cerberus, and portions of the Frost Dragon.

At first blush, tales of the spontaneous creation of complex models can be quite intimidating. The natural reaction is to assume that these people are some sort of mutant supra-geniuses, and are so intelligent that designing organisms is so trivial to them that they can simply do it in their head.<sup>1</sup> The other alternative that springs to mind is that these designers have some sort of special link to some external spiritual force, and that the ideas "passed on" to them directly from that source. In any case, either of these scenarios is likely to seem quite unattainable to the average reader. As an alternative, I encourage a third, less obvious explanation, which is more concrete and approachable. I have to do with the functioning of the human brain, and the sub-conscious mind.

On the most fundamental level, the functioning of the brain can be broken down into two main areas: the conscious mind and the sub-conscious mind. The conscious mind is the portion of the brain at which most individuals are most aware. It is in the conscious mind that most "verbally-based" thought goes on. This is the part of the mind that is concerned with perception and analysis of problems. In the most commonly accepted point of view, when you are "thinking," it is your conscious mind that is doing the work. But there is much more to the mind than these verbal thoughts. Below the level of conscious thought, there is another extremely powerful, but less attainable level of processing going on in the sub-conscious mind. This level of thinking is "truly, Below the level of the conscious." Unlike the conscious mind, however, the sub-conscious thinks not in terms of language or figures but rather in terms of visualization, sensory activity and emotion. When you go to sleep, it is the sub-conscious mind that produces your dreams, representing your experiences and sense of being to you in visual form.

The sub-conscious mind is much more powerful than people might suspect, in fact it may be more powerful than the conscious portion of the brain. Rather than simply being a generator of dreams, the sub-conscious is always functioning at full steam, processing and analyzing things in a more abstract way than the conscious mind could ever do. But unlike conscious thought, the sub-conscious functioning is silent. It works in the background, processing a problem until a solution (or solutions) is reached, at which point it "kicks" the solution to the forefront of the brain, the conscious mind, where it appears to the thinking mind as an innovation, or "blast from the blue." People often refer to "knowing something subconsciously" or having an "intuition" about something. These are examples of subconscious functioning, working to solve problems while the conscious mind deals with more mundane issues such as what to have for breakfast or what to wear to work. The sub-conscious is not only the seat of intuition, but also the location of the thought processes that are credited with much ESP-type phenomenon such as clairvoyance (the ability to know the locations of objects without prior knowledge of their whereabouts), precognition (the ability to know the outcome of events before they occur) and telepathy (the ability to read the thoughts of others) which are all, in my opinion, simply examples of our subconscious mind functioning in ways of which we are unaware, and that these ESP effects are actually our subconscious mind picking up on things of which the conscious is not aware. Subtle body language for example, or a vague and obscure association of one object with another that has been forgotten by the conscious. In the future, I believe that as scientists

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<sup>1</sup> Like the famous composer Mozart, who is reported to have composed his symphonies in entirety, before ever putting a single note to paper.



unlock the secrets of the brain, the functioning of these occurrences will become well understood. It is in learning to utilize the subconscious mind that I feel true genius resides, through gaining the ability to solve problems with that portion of your mind which is actually more powerful but more difficult to access.

Throughout my life I have always put a lot of credence into this approach to problem solving and use it whenever possible. Often in my work I am presented with a problem to which I know intuitively there is a simple solution, but haven't the slightest idea how to proceed. In these cases I leave it up to my subconscious to come up with the solution. I study the problem, gathering all available information with my conscious mind, and then simply move on to another task and let my subconscious work on the problem. Sometimes the solution takes days or weeks, but eventually it comes. I refer to this approach as "putting a problem on the back-burner". As my models have increased in sophistication I find myself leaning on this method more and more, and have many approaches to trying to help invoke my subconscious to solve problems on my models. I often use the back-burner approach, simply putting a model on the shelf for awhile to allow myself to get some distance from the problem. For often when I return to the model the problem will solve itself quickly and easily. Another method I use is to take the problem to bed with me. I've used this approach when working late into the night on a problem that I cannot solve. After awhile I simply start the paper, trying consciously to take in the form of the model and learn where things lie. Then I go to bed, holding the model in my hand so that my subconscious mind will solve the problem while I sleep. I used this technique extensively while working on the first dragon and solved many problems using it, including the design of the wings and tail as well as the subsequent positioning sequences. Again in the later portion of the development of this book I have relied heavily on my muses for inspiration, relying on them to guide and inspire me through my writing. These approaches are not as strange as one might think, and are simply ways of getting the subconscious to work for you. Every body has these powers, the trick is exercising them so that they can be more easily utilized, and the trick to learning to use them is again practice. There is a fledgling science called "dynamics" devoted to an study of the power of the subconscious mind and learning to tap its powers. Many good books are available on the subject.

**Philosophical** The philosophical approach to creating is more an alternative way of looking at organic than it is a strategy for design. It stems from the traditional Japanese view of organic design where organic's ability to capture the visual beauty and elegance of a subject with a few simple lines and curves is greatly revered. Philosophical creators are more concerned with capturing the artistic essence of a subject than in challenging themselves with the technical issues of design. It is a more naturalistic approach wherein the subject of each model is studied extensively before and while the designer is attempting to render it. Philosophical creators are less concerned with achieving fangs and claws, accuracy than in creating a model which evokes the simple, stark elegance of a subject, one which has a hint of the life spark of the plant or animal being rendered.<sup>1</sup>

By nature, models created under the philosophical school of thought tend to be more stylized and less detailed than those created with a more western approach, though this is not always the case. It is perhaps here that the distinction between origami as an art form and origami as a hobby first started to evolve, for often these models are designed in such a way that folders are forced to impose their own artistic vision on the subject. If one were to apply the music analogy used previously wherein designing origami models is like writing a piece of music that a performer can repeat over and over, these philosophical pieces would be akin to jazz compositions, wherein a major portion of the music relies on the improvisation of the musician performing the piece, and where each performance will be different from all previous performances. For rather than having a straightforward set of instructions which always produce the same model, the piece may contain folds which are not well landmarked, which lead to variations in the finished subject, also, the models may contain finishing steps which are too subtle to diagram and rely on the folder to lend his or her own artistic view. Unfortunately, this variability in the design of the model can make

<sup>1</sup> Generally, philosophical creators are more interested in rendering living forms rather than inanimate objects.  
• Rather than showing precisely where a crease falls on the paper, require the folder to judge where a fold goes.

diagramming particularly difficult to the degree that many of the models truly cannot be accurately diagrammed and must be taught in the traditional hands-on approach. There are also many pieces produced by philosophical creators which will never be diagrammed or reproduced and can only stand alone as singular works of art, representations of the true vision of their creators. Excellent examples of this type of work can be found in the designs of the great Japanese masters Akira Yoshizawa & Kunihiko Kasahara as well as the American artists Michael LaFosse & Stephen Weiss.

**Analytical** This is the first of the methods wherein a more directed approach is taken. It is used when the creator knows exactly what he or she intends to create and is going through the process of discovering and/or figuring how to do so. The method is somewhat straightforward and logical, consisting of analyzing the structures of existing models or failed attempts in order to come up with a base or solution for a particular problem.

There are two types of analysis, deductive and inductive. Deductive analysis is a common approach used when designing paper airplanes in the case where the first model is folded accurately and when a subsequent model is folded incorrectly. This is the approach that I used in recreating the Tarantula Dragon. When this happens it is up to the creator to deduce what the subtle differences are between the original model and the copy. To solve the problem, the designer must go through a systematic approach of changing small variables in the model, perhaps some small proportion in folding or a single cut in the surface of the wings, or perhaps the material used or the sharpness of the creases until the proper set of variables is found and a flying model results. In many cases the completed piece is somewhat different from the original, but that is all part of the creation process. This type of reasoning is called deductive because the creator goes from the realm of all possibilities and subtracts from them until a single case is found.

In the other type of analysis, inductive, the exact opposite is true and a specific case which already exists is analyzed in order to create a more general case. For example, when I was designing the Crown Dragon, I wanted a wing approach that would allow me to create two very large and separate flaps of paper that could use as the wings. So I took as a starting place a model which had similar structures, Peter Engel's Butterfly. I studied the model mostly from the illustrations in the book, and ascertained exactly how he had solved the problem. I found that the approach was really quite straightforward once I was able to see it from a macroscopic rather than microscopic point of view; it was easy to isolate for the general case. Unfortunately, the regions of paper were oriented in the wrong direction, so I studied another model, Matthew Green's Dragon, and found that his approach for the wings was even simpler. Finally I integrated the two to create the utterly base that I finally ended up using. This type of analysis is called inductive because one moves from a specific case (an already existing model) toward a more general application which can be included in other models (the butterfly base).

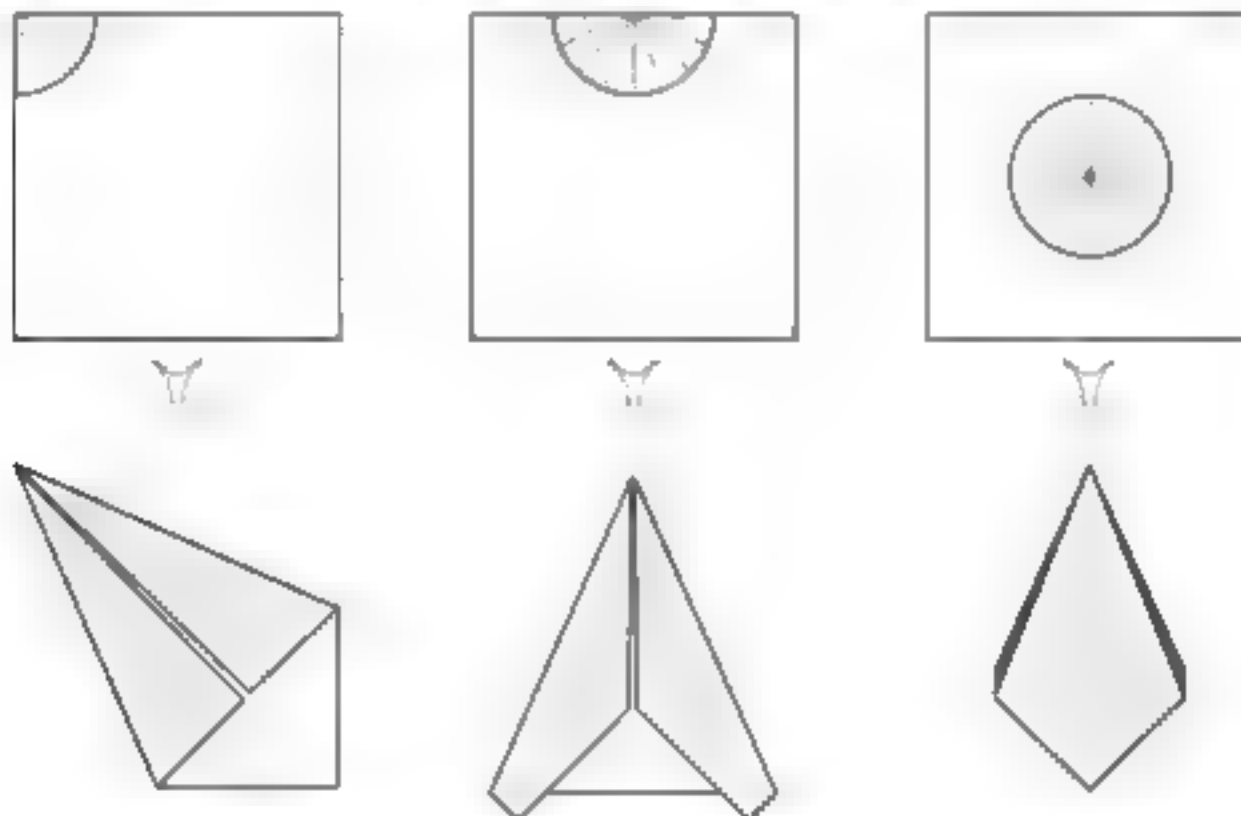
There are also cases where both approaches are used to solve one problem. For example, when I created the multi-copper versions of the traditional bases, I first studied the geometric structure of the already existing four-flapped bases and came up with a more general case that enabled me to understand how multi-flapped bases would have to be structured in order to be folded from a single square of the paper. This was inductive reasoning, moving from a specific case to include other cases. I then proceeded to come up with a logical approach that would allow me to fold each of the specific bases and found that a completely different approach was required for each case. This was deductive reasoning, starting from the general case and moving to the specific.<sup>1</sup> Most of the complicated models in this book have relied upon this method to some extent, including the Dragonfly, the Tarantula (which is why I created the multi-part bases), the Sea Anemone (which was done deductively not inductively), the Crown Fish, and many portions of the Frost Dragon.

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<sup>1</sup> A more detailed explanation of this analysis can be found in the Bases section.

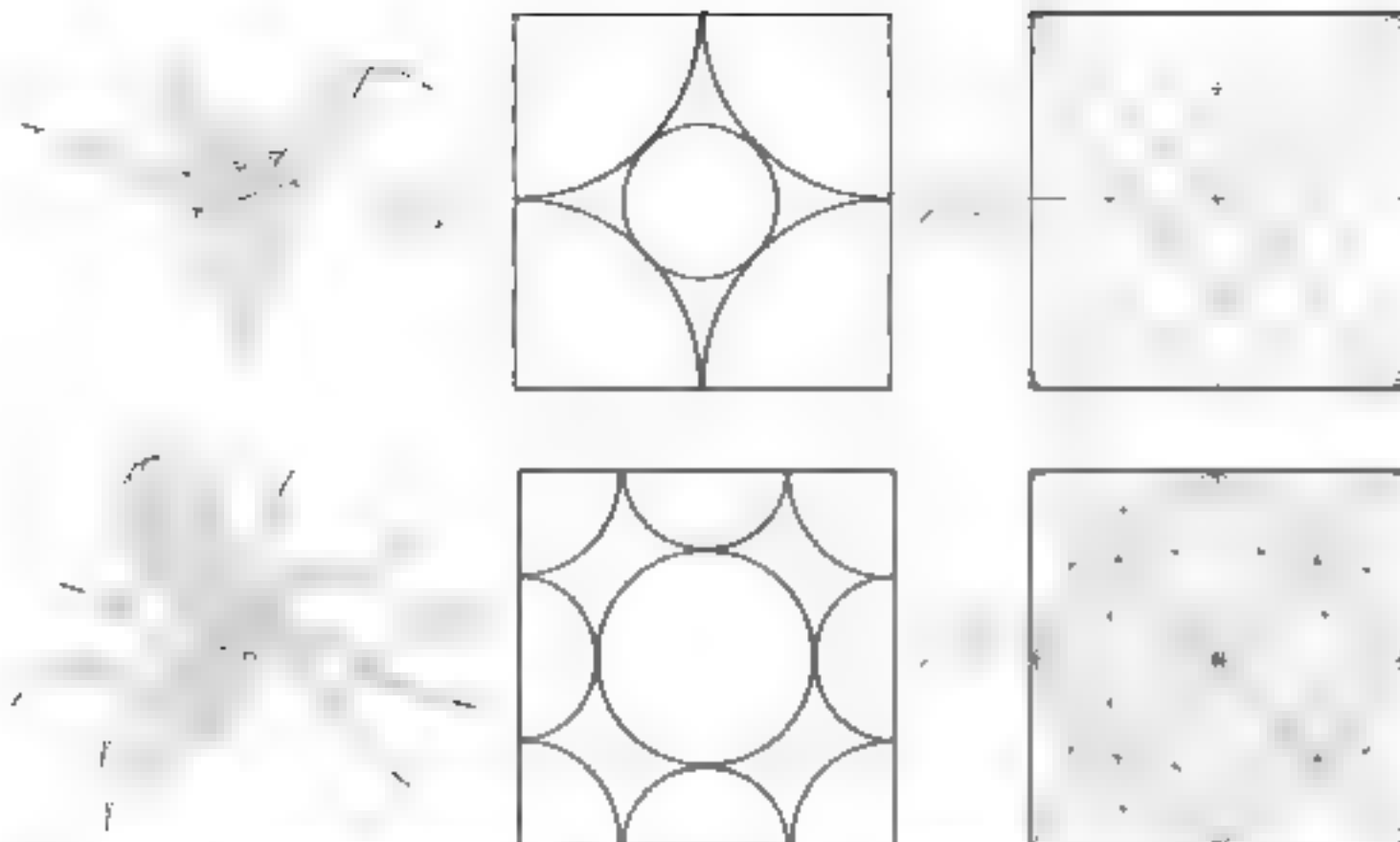
**Topological** When I first heard about this approach it terrified me. As I understood it, there were some creators who worked their entire model out on paper mathematically before ever making a single crease. I had visions of them working out the complicated folding sequences in their heads, as if they could actually keep track of the model's entire geometry, and then simply folding the model in one attempt. Fortunately this romanticized version is somewhat of an exaggeration. In actuality, the topological method is a straightforward and logical approach to creating origami bases based on the premise that all origami models are composed of an integrated array of points. The name is taken from the mathematical term "topology" which is defined as "The mathematical study of the properties of geometric figures that remain unchanged under distortion, so long as no surfaces are torn, and 'topography' which is the science of drawing maps in such a way that they can represent three dimensional surfaces. The approach is based upon two simple points — that a given model is composed of a limited and identifiable number of points, each representing a single appendage of the subject, and 2) on a flat surface of paper, there are limited ways of introducing points from the available material. Given that these premises are true, then logically — one can identify the appendages that the model requires, in the proper number, proportion and location — one can then follow a logical progression of steps to determine the best arrangement of these points on the paper surface, no matter how complex the subject, and then proceed to collapse the mapping into a base from which the model can be folded.

Unfortunately, this is not a simple task. While defining the array of points is a relatively straightforward process, moving from them to the topological mapping can be quite a challenge because there are so many ways to arrange the points. But after this, the real challenge comes, which is taking the topological mapping of points and actually folding them into a base. This is extremely difficult and, in most cases, the creator must rely on the other approaches to designing in order to do so. Generally, the model and topological mapping will undergo extensive modification before a workable base is found.



Figuring out possible bases for the points array that all origami models are composed of is an art. If points are placed on a figure which point and where to place them then they will have an ideal base from which to sculpt the final design. There are three possible ways of creating a point, from the corner, from the edge or from the center. Notice that each type takes progressively more paper.

- 1. In fact, some creators utilize computers to execute the topological mapping.
- 2. In fact, there is no guarantee the creator will be able to find a logic of progression of steps that allows a base to be created which follows the topological mapping which was established. Though, even in the mathematical realm of all possibilities, a solution probably exists, it remains to be seen whether the creator can find it.



where the final shape is the intended form, but some of the points are not at their relative spots in the final shape and are difficult to fix. The process is a balancing act, which requires an almost instantaneous insight. Whether the designer has one and a way to actually fold the creasing pattern is the greatest challenge of the process.

While the topological approach is challenging, it also produces some of the most spectacular and delicate to fold models known, including a hermit crab,<sup>1</sup> an octopus with tentacles, eyes and blow tubes,<sup>2</sup> and a Japanese shrike on a branch with wings, fingers, pointed tail and a full array of facial detail.<sup>3</sup> I once had the good fortune of attending a seminar where the approach was described in detail by one of its most accomplished followers. It became clear to me that while it is extremely powerful like other methods it must be practiced and honed by the creator over time for it to work well. There is also an additional difficulty, for with such a logical progression of steps being followed, the completed piece can take on a somewhat "cybernetic" appearance. The creator must take special care to add additional steps upon completion of the model to assure that it takes on an esthetic personality of its own and does not appear "cold" or "stiffed." In my own experience, it was both exciting and frustrating to use when I applied the techniques when designing my leaping lizard. In this case, I had a particular subject in mind and a good sense of its proportions, and proceeded to work out the mapping on the paper. Within a matter of minutes, I had collapsed the paper into my first version of the model. The result was close, but missed the mark somewhat.<sup>4</sup> And naturally, it took another three months for me to repeat the process in a way that could be diagrammed. Upon completion of the lecture, it was clear to me that after several years of studying the topological method, the instructor had a profound understanding of it that can only come with a great deal of practice and experimentation. If you are interested in learning more about the topological approach to design, I strongly recommend that you review the work of the better known topological folders, including Robert Lang - "Organic Zoo" (co-written with Stephen Weiss), Peter Engel - "Folding the Universe" and Jun Maekawa - "Viva Origami."

<sup>1</sup> Robert Lang - "Origami Sea Urin"

<sup>2</sup> Peter Engel - "Folding the Universe"

<sup>3</sup> Jun Maekawa - "Viva Origami"

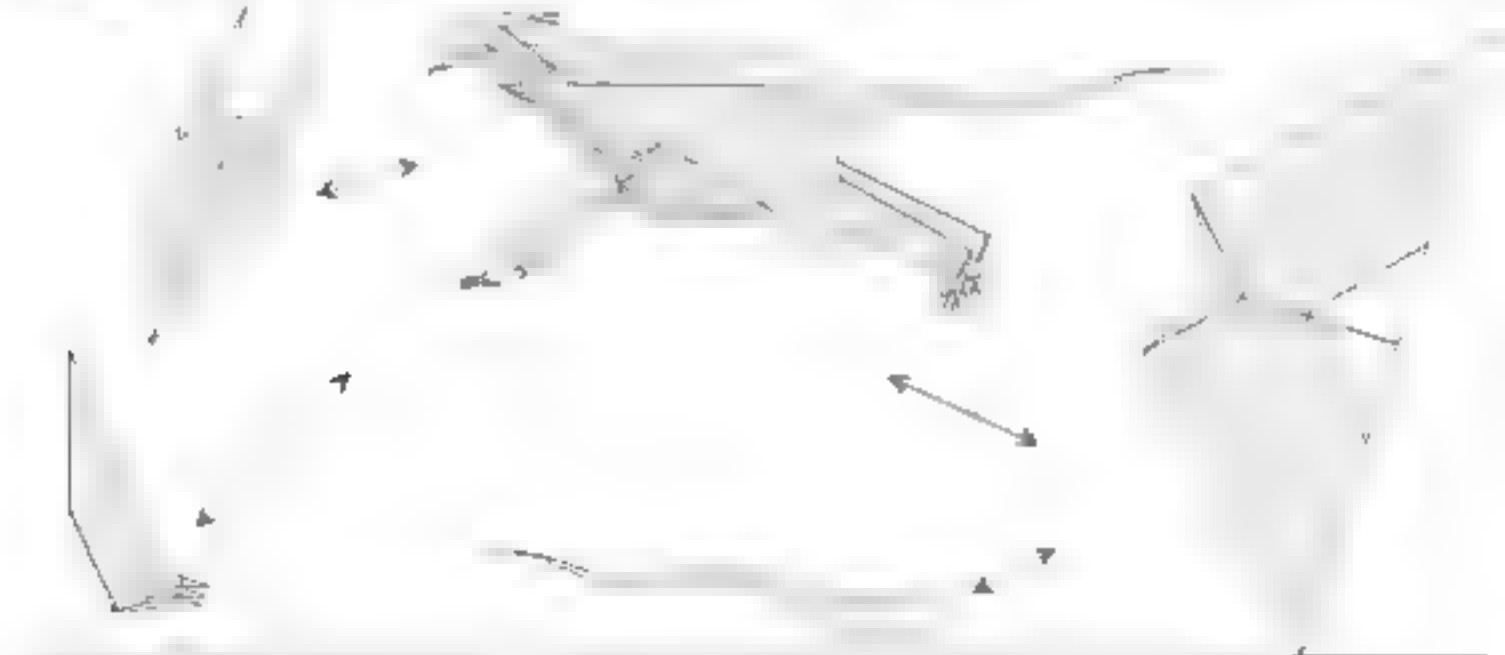
<sup>4</sup> My original subject was a fictional creature which more closely resembles a kangaroo than a lizard.

<sup>5</sup> Look for another version of the original subject to be published in a later book. I'll get back to it eventually.

**Piecemeal** This is probably the most unnerving and difficult approach to design I know, but it also produces the most spectacular models. It is closely related to the topological method and is used by many well-established topological creators such as Robert Lang who uses it on his “constructive monster” models such as his “Black Forest Cuckoo Clock.” It was used to produce both my “Clown Fish & Sea Anemone” and “Frost Dragon” models. I don’t recommend it for the faint of heart, but for accomplished folders it will allow the greatest level of creative flexibility because the creator has total creative control of every aspect of the work.

In the piecemeal approach, each portion of the model is designed independently. Upon completion of all the separate pieces the creator is faced with the extremely intimidating task of “sewing” each of the pieces together to form a cohesive whole. This is done by designing the separate parts so that they can be easily folded from a single flap of paper, such as a diaper fold, rabbit ear, or double rabbit ear, and then creating a base which creates and correctly arranges the appropriate flaps. Doing so is no simple task, not only because it is difficult to locate each portion of the model in the proper place and proportion, but it is extremely likely that as the details of the model are folded, they will interact with each other and cause a “synergistic” effect making it impossible to fold them simultaneously. The creator must employ a strategy when designing the separate portions of the model to assure that they can be folded in such a way so that they will not affect the adjacent paper, or must anticipate it and work it into the design.

I first used this process when designing the Frost Dragon. I started by creating the wings, and then created the head, with its jaws and horns from a separate piece of paper. I then had to figure out a way to integrate the head with the rest of the model, which was quite a challenge. Next I added the tail to the wings, which forced me to reevaluate the wing structure. The feet and claws were relatively simple to design, but the task of putting four legs on the model in differing proportions was daunting. After all of that had been accomplished, I discovered that the head was pointing in the wrong direction and it appeared that the model would not work at all. To solve the problem I was forced to impose a huge construction composition on the head, which was an extremely difficult and intimidating process because there was no guarantee that a solution actually existed.<sup>1</sup> Ultimately the model did come together.<sup>2</sup> All in all it was a very sultry and convoluted process, but it led to a wonderful model because I had the freedom to create each part exactly as I liked.

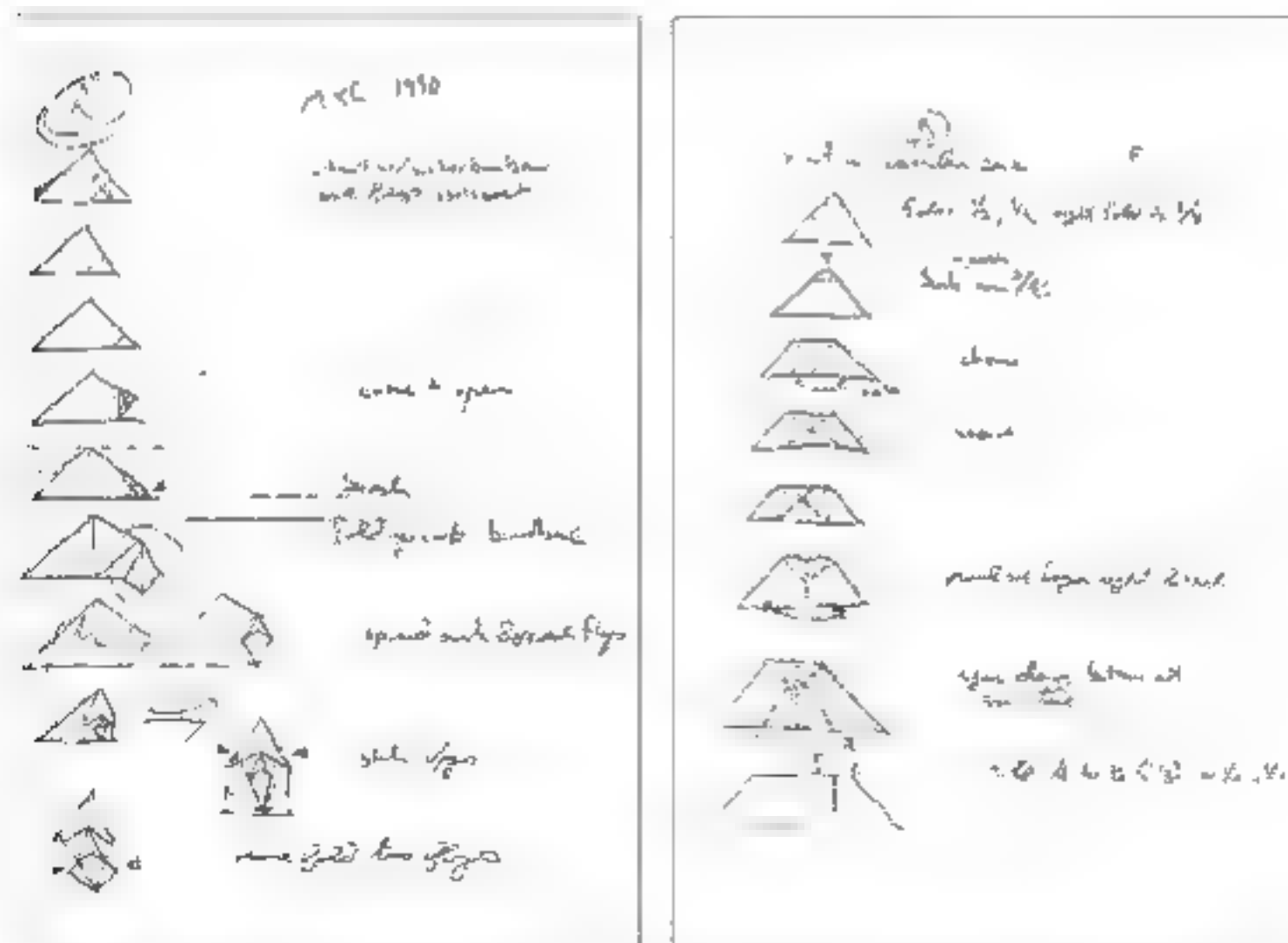


- 1 Using an inductive-analytical approach.
- 2 A simple model created from a bird base.
- 3 One folder (me) complains the fact that he has a face in his head, all of it. The most wonderful animal heads you've ever seen\* which he has never been able to integrate into a completed model.
- 4 Twice actually. For when Iagranmes completely re-did the model's proportions as well as re-implementing the construction that positions the head.

## Keeping Track of where you've Been - Diagramming

While designing a model is difficult, even more important is being able to recreate what you have done. There are several different approaches of documenting your work, and as with the creation approaches, it is likely that you will use some combination, depending upon the model you are working on.

The simplest approach is to use step folds. Step folds are intermediate versions of the original model, done on separate pieces of paper. The commonest example occurs when a diagrammer is diagramming someone else's work, and there is no other way to learn the piece, because it has never been diagrammed previously, and the designer is not on hand to teach it. In this case, the creator will produce several intermediate models, one for each step in the folding progression, and number them to indicate the correct sequence. Using these, the diagrammer can deduce the original folding process, since there is very little change from one piece to the next. Creating step folds in this way is an extremely tedious and time-consuming process, but in some cases it is the only way for creators to document a piece, particularly in the case where they are disclaimed or unable to diagram on their own. This approach can also be used during the creation process: in this case, designers can use a modified approach and only create a secondary piece each time they feel that the model has changed enough that they might lose their way. For example, when I am working on a model, and I come upon something interesting, perhaps a particular move or new way of approaching a problem, I immediately put the paper aside and repeat the folding sequence with a new piece. There are two advantages in doing this: it gives me an opportunity to make sure I remember and understand how I got there in the first place, and once I have reproduced it, I have physical documentation of what I have created.<sup>1</sup> These examples are then put aside until when they serve as stepping stones during the diagramming process.

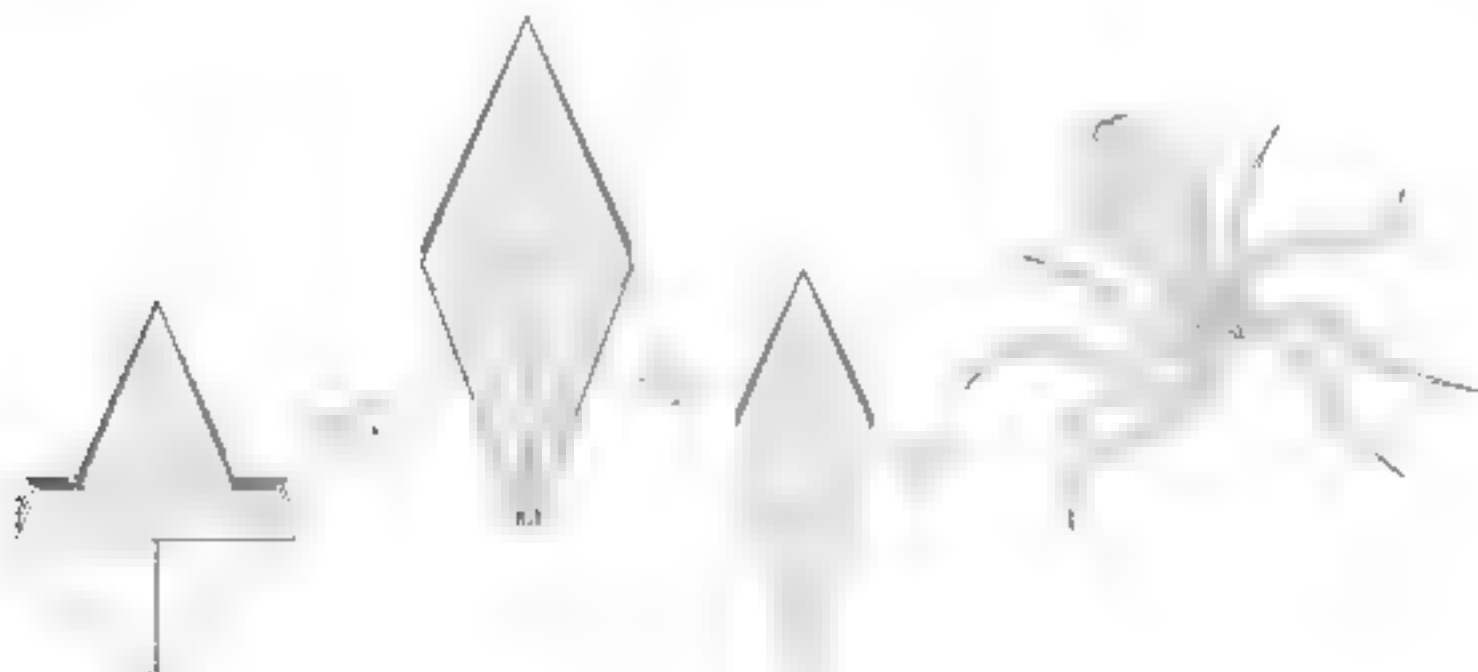


<sup>1</sup> When I created the Frost Dragon I generated over 100 of these intermediate step models.

Another approach to saving your work is taking notes. Generally when I am creating the step folds as I described above, I take rough notes on notebook paper to document the folding process. These notes need only be as accurate as you need them to be, in order to enable you to recreate the folding sequence. My notes tend to be extremely rough, but extensive in detail. Often the illustrations will translate step-by-step into diagrams. While creating the Frost Dragon, I took over twenty pages of notes on the various parts of its anatomy, liberally reordering the pages as I progressed. Unfortunately, some models do not lend themselves well to being diagrammed, since they contain in their design the opportunity for a great deal of variability. Models created under the philosophical approach often fall into this category. In response, some creators are experimenting with other methods of documenting their models through alternative techniques such as photography and videotape.

When I first started creating, I had the opportunity to speak with one of America's better known creators. I asked him how he, as that designer, kept track of their models during the creation process. His answer was not encouraging. He stated succinctly, "It's simple, you memorize them." Yeah, maybe for him. "I thought, 'Well, it turns out that his answer was sincere and accurate, if a little evasive.' It is possible to memorize your designs while you work, but not in the sense that one might expect."

Simple models can be memorized, but when the model consists of complex folding sequences and many steps, how is it possible to remember the entire folding sequence? The secret lies in the difference between how creators think of their work, and how it is perceived by a folder following diagrams. When folders are following a series of directions, they perceive the model from a continuous view, meaning they view the model only in terms of its details, moving from one fold to the next, making only one decision at a time. Designers, on the other hand, see their creations not in terms of single folds but in terms of procedures and objectives, the result of a series of processes. For example, while to the folder a construction appears as a relatively seemingly unrelated series of steps being executed simultaneously, the designer sees it as a single maneuver, executed to accomplish a single specific objective. This way of seeing things is called a macrocosmic point of view, where the observer looks not at the details, but rather at the big picture. This difference in perspective is a great help to creators in that it simplifies the creation process by allowing them to see models in terms of objectives and solutions rather than as a long series of seemingly unrelated cases.



It is in this macro-cosmic point of view that it becomes possible for creators to memorize the work as they design. They remember the model in terms of what their objectives were as they designed it, rather than concentrating on each and every crease. For example, I first discovered my Octopus while I was investigating the effect of varying the creasing ratios on the spider base. I fell upon the model completely by accident, but the approach was so simple that I never felt the need to take notes on how it was folded. From a macro-cosmic view the model is extremely simple—start with a spider base in the lowered configuration, execute four double-petal folds, execute pleat sinks to thin the legs and sculpt the model into shape. It may sound complicated but conceptually it is really only a four-step process. In fact, the sequence is so simple that I had no record of how the model was folded until I finally diagrammed it eight months later. Unfortunately, this approach does not always work. I used the same method to remember the Wuli Spider and forgot how to execute a major portion of the model. This led to quite a scare when I got back to six months later and discovered that the model no longer worked and was forced to scrounge for the missing portions. It was after this that I started taking notes on my work as I designed.

Unfortunately, this difference between how the creator views the model macro-cosmically and how the folder views it micro-cosmically is precisely what makes diagramming so difficult. Converting from one point of view to the other can be quite a challenge. For example, I folded my first version of my "Escaping Lizard" in a matter of minutes, but it took me three full months to repeat the sequence in a way that could be diagrammed. For when diagrammers record models they must convert their way of thinking from a conceptual, objective-based approach to the very specific, step-by-step view of the folding process reflected in diagrams. This can be rather difficult to accomplish, but if the diagrammer keeps this difference in mind while working it will make the task simpler. For each macro-cosmic step, think first of what you are going to do conceptually and then do it. But as you execute the fold, notice how it is that you go about executing the process. Do you landmark the paper? If so where and how? Do you precrease? If so where and how? Where do you locate the paper? How do you orient the model as you work? After you have completed each step, gently unfold the paper to the point prior without flattening the paper and observe the direction of the creases. Now you can proceed to convert all these details (landmarking, precreasing, orienting, etc.) into separate steps and diagram them in turn.

Often, as you convert from the creator's view to the folder's, you will find you self-censoring, slowing the model by adding landmarks, precreasing, etc., to simplify the folding process so that it is easier to follow. You find yourself acting in the role of editor, looking at the model and finding more efficient or straightforward ways of presenting the material. This is a normal part of the diagramming process, but in some cases becomes a problem when you are diagramming work that is not your own. In this case, you must be very careful that you do not change the final form of the model in any way, and that you do not offend the original designer during the process. Different people have differing levels of tolerance with having their work edited, and you must be sensitive to that. But if it comes down to it, remember that if you are doing them a favor, you can simply request that they let you do it the way that you feel that is best. Clearly, one must be respectful to the feelings of the designer, but if he or she is choosing to allow you to diagram their work, they must also be respectful of your feelings as well.

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1. An interesting aside with regard to the macro-cosmic view: While I was designing my "Sea Anemone," I had a good sense of how I was going to approach the design—create a form with seven isolated flaps and then execute a quadruple-spherical inversion of the flaps to produce a twenty-five-point base. In my attempts—experiments I with various methods of creating a seven-flapped base and in the course of my experiments found those working with a four-flap—inspired me to invent a method. After folding many with my new method I realized what I might be and after looking my library I learned I was right. I discovered that I had taken liberty and a brief vision all the way to step 17 without the use of the folding instructions and only once I've almost folded the model approximately one year prior. It was the macro-cosmic point-of-view that allowed this unlikely invention to occur. For while I am often doubtful that I could do identically and so with a complex model without the aid of instructions with a little imagination and a "big picture" outlook, now it was quite natural as to do it in the same solution. I later abandon that method for the folded-wire-knife-base approach used in the final model, but it is interesting to note how easy and logical it was for us to find similar solutions based on our common objective.



There are many other issues that you must take into consideration as you evolve your diagramming style. How detailed will your work be? Will you make the drawing appear to be 3D, showing multiple layers, or will you utilize a more simplified approach which shows only the top layers of paper? Will you use a computer? Or work with pen or pencil? Will you use the standard notation or modify it to better suit your needs? Will you use some text, a lot of text or no text at all? Will you use many directional arrows and additional symbols? Or do you feel that these elements confuse the drawing? Each of these variables must be worked out by each diagrammer according to his or her own style. But keep one thing in mind: the objective of your diagramming is to allow someone to build a model which they have never build before. To stack the odds in your favor, it makes sense to give as much information as possible to the reader. Adding detail takes more time, but the end result are diagrams that are more likely to be understandable and less likely to frustrate or alienate the reader. And with regard to whether or not to show a few complicated steps or many simple steps, one of my students put it quite well: "I don't care how many steps there are, as long as I can do them."

## Origami as an Art Form

Over the past decades origami has grown in acceptance and popularity. While historically it has been viewed as an enjoyable and intriguing activity which could be shared by both the young and the young at heart, it is in fact a fledgling art form that is just now beginning to reach recognition. A similar sort of transformation has been seen recently in the realm of comic books. Traditionally comics have been viewed as "pulp fiction" consisting of mindless stories with shallow characterizations and thematically empty picture lines. But over the last decade there has been a movement by artists such as Frank Miller, Alan Moore & Dave Simm to create comics of literary and artistic merit. This led to early significant works such as *Kull*, *Dark Knight*, *The Watchmen*, and *Cerebus*. Each of these works is literally a novel, presented in graphic form. The success of these initial efforts led to an increase in the production of comics of greater substance which led to more and more artists jumping on the comics bandwagon.<sup>1</sup> And so it is with paper folding. While previously it was considered by most to be a hobby like needlepoint or model rocketry where following the directions and completing the project is the triumph, there is a growing perception of origami as a specialized form of three dimensional art where the objective is to create beautiful forms under extreme limitations, produced by simply folding a square piece of paper.

Historically there have been many forms of art where such limitations are imposed. The Shakespearean sonnet, for example, is a poem wherein the author must follow very strict guidelines. It must contain exactly fourteen lines of text which are broken up into three sets of four, followed by one set of two. It may have a specific rhythmic form meaning that all accents in words must fall in a particular pattern. There is also a very strict rhyming scheme where the first line must be rhymed with the third, the second with the fourth and so on. In classical Western music similar forms can also be found. One example is the "Canon" wherein a piece of music is played on the piano by one hand while the other hand plays the same line but out of synchronization with the first. The "Crab Canon" is another example wherein a line of music is played by one hand, while the same piece is simultaneously played backwards by the other. As difficult as these canonical forms are to play, they are significantly harder to construct. For not only must each note, each line, work well with the others surrounding it, they must also sound pleasing with the same line being played backwards or out of synchronization with the first. Avoiding dissonance under these circumstances is a formidable task. Origami then, is a form of sculptural sonata in paper. It is a puzzle and engineering achievement as well as an aesthetic form. It is an intriguing juxtapositioning of science and art, of right and left. For much of the artistic process is hidden inside the model within the techniques and solutions which were utilized by the designer to produce the actual folding sequence. And while for the artists and designers a great deal of variability in the final work can be derived through choice of media and folding technique, now through designing original models can they gain complete control over their work.

But with this evolution, myriad questions come to mind. What is art? And what is its relationship to origami? At what point does origami cease to be a craft and become an art form? The distinction can be drawn based on the intention of the folder. Is the point of folding to generate a product, something that is to be viewed and possibly admired? Or is it successfully completing the actual folding process that is the motivation? If your intention of folding is to create something that others can admire, then you are approaching origami as an art form. If on the other hand, the attraction of folding is simply going through and completing the process, it is more akin to a hobby. It is the ultimate intention of the folder with which I am concerned. For creating works that are esthetically pleasing is quite a task. But as more folders pay attention to issues such as choice of media, folding technique, presentation and other esthetic aspects of the process, the artistic aspects of origami becomes more substantiated.

1 Which incidentally is indirectly responsible for the deluge of comic book related caperna such as *Batman* and *Teenage Mutant Ninja Turtles* which has become so prevalent in the last decade.

2 The song *Row Row Row Your Boat* is a well known example of a canon.

3 Fascinating descriptions of these and other musical forms can be found in the book *Crabnet: Aether Ball* by Douglas K. Friestadter.

But more complicated issues arise. For when one starts to talk of something as being art, one must first define what art is. The common view is to look at art as a thing, an object which is created for the pleasure of others. I see art rather differently. I see it not as an object, but as an experience. The emotional reaction that takes place in the viewer upon observation of the object. I see art not as a painting, or poem, or ballet, but as the experience of the observer of the painting, or the book, or the ballet. Art is not what the artist creates; it is what the viewer experiences. Art is any experience which evokes emotion. A play, a painting, a symphony. But art is also a sunset, a playful kitten, rolling ghetto, or the devastating loss of a friend. With this view of art, the role of the artist is to create objects or experiences which will evoke emotion in the viewer. Art is a form of communication, from the artist to the viewer. But in the case of a sunset, who is the artist? What is the emotion that is conveyed? What was the intention of the artist? Ignoring the philosophical arguments on the issue, and assuming that the artist's intention is neutral, the experience is left totally up to the viewer. It is purely subjective. Based on the attitude of the experiencee. Many people are obsessed with the beauty of a sunset. But a child playing baseball might be disappointed, because it means that it is time to go home. And one who has lost a friend might feel melancholy that he or she could not be there to share the experience. Three different people, three different reactions. This is art in its purest form. It is with this concept of art without artist, without intended or inherent meaning, that I am writing for. I see that art in which the artist had no intention to convey emotion or meaning is the purest form of art. By "purest" I do not by any means mean "the best" form of art, but only that the possible range of emotions experienced by the viewer is larger and less restricted when the artist had no original communicational intention. Of course, one might ask how can the artist create without imposing meaning? It is nearly impossible for artists to not incorporate their attitudes or points of view into their work. The best way that I have found to do so is to utilize random elements in the creation process. When I was started as an artist, I strived for that meaninglessness, but have since moved towards expressing my emotions through my work.

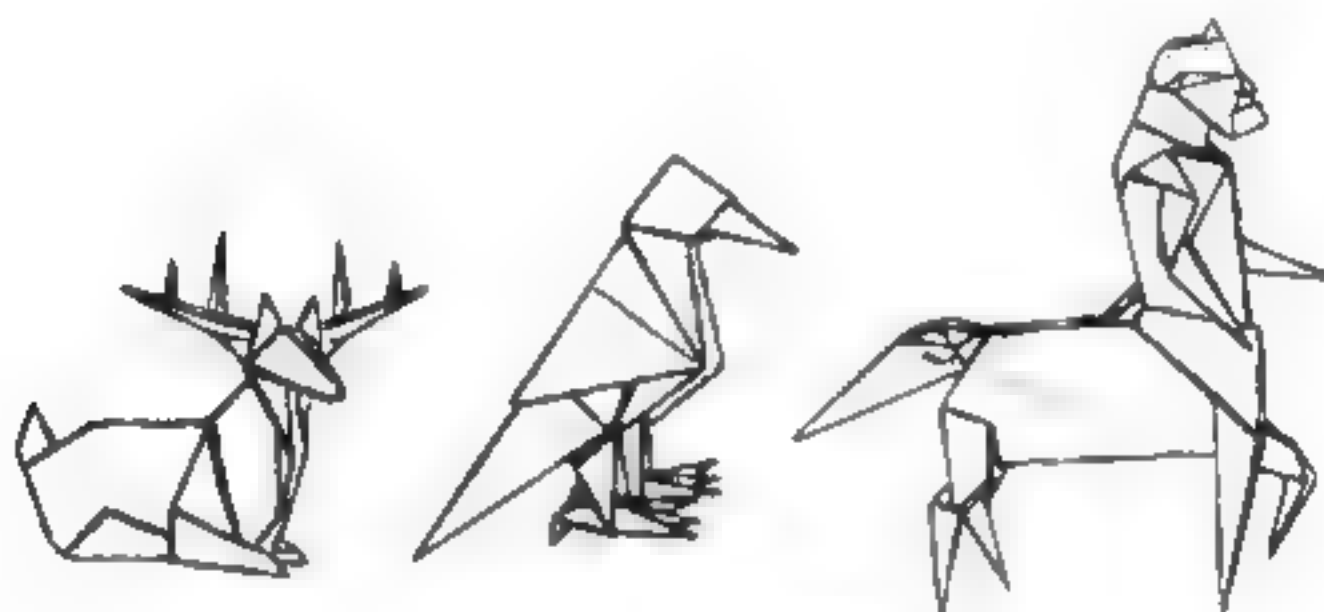
But back to the point. If art is an experience, there are at least three major participants in the experience: who can and do bring their points of view to the artistic experience. They are the composer, the performer, and the recipient. For example, in the case of music, there are three main individuals who are a part of the "work". First the composer, who has created the initial framework from which the piece will be created. Next come the performers, and if appropriate the conductor, who bring to the piece their own individual style of interpreting the music, and who may have unique ideas about the best tone, accenting, phrasing, and temperament. The final participant is, of course, the listeners, who bring their own points of view, attitudes, and moods to the experience. All these elements mesh together to produce the "artistic experience" in the listener. Similar parallels can be drawn in the case of a painting, from the painter, to the person who sets up the exhibition, and finally to the viewer of the painting.

But one embraces the view of art that I have presented, then how does one create art in organic, is it possible to do more than simply create an object of beauty? Is there a way to evoke emotion through paper folding? When one examines the work of Michael LaFosse, and observes his remarkable ability to capture the life spark of a subject, and the exquisite level of subtle detail he achieves, they are likely to be awed. And truly, the complexity and sophistication of the work of Robert Lang are sure to evoke awe in the viewer. Similarly, a young child introduced to the "Hopping Bird" or "Butterfly Ball" is sure to be delighted by the experience. There is also art to be found in the engineering aspects of the process. For often is the case that emotion is experienced by the folder in the process of deciphering a new model, and upon the process of completing the work, elation or perhaps utter disappointment. A whole range of emotions have been evoked through the experience of paper folding. So, if one chooses to create a work of art in organic, there is clearly much opportunity to do so.

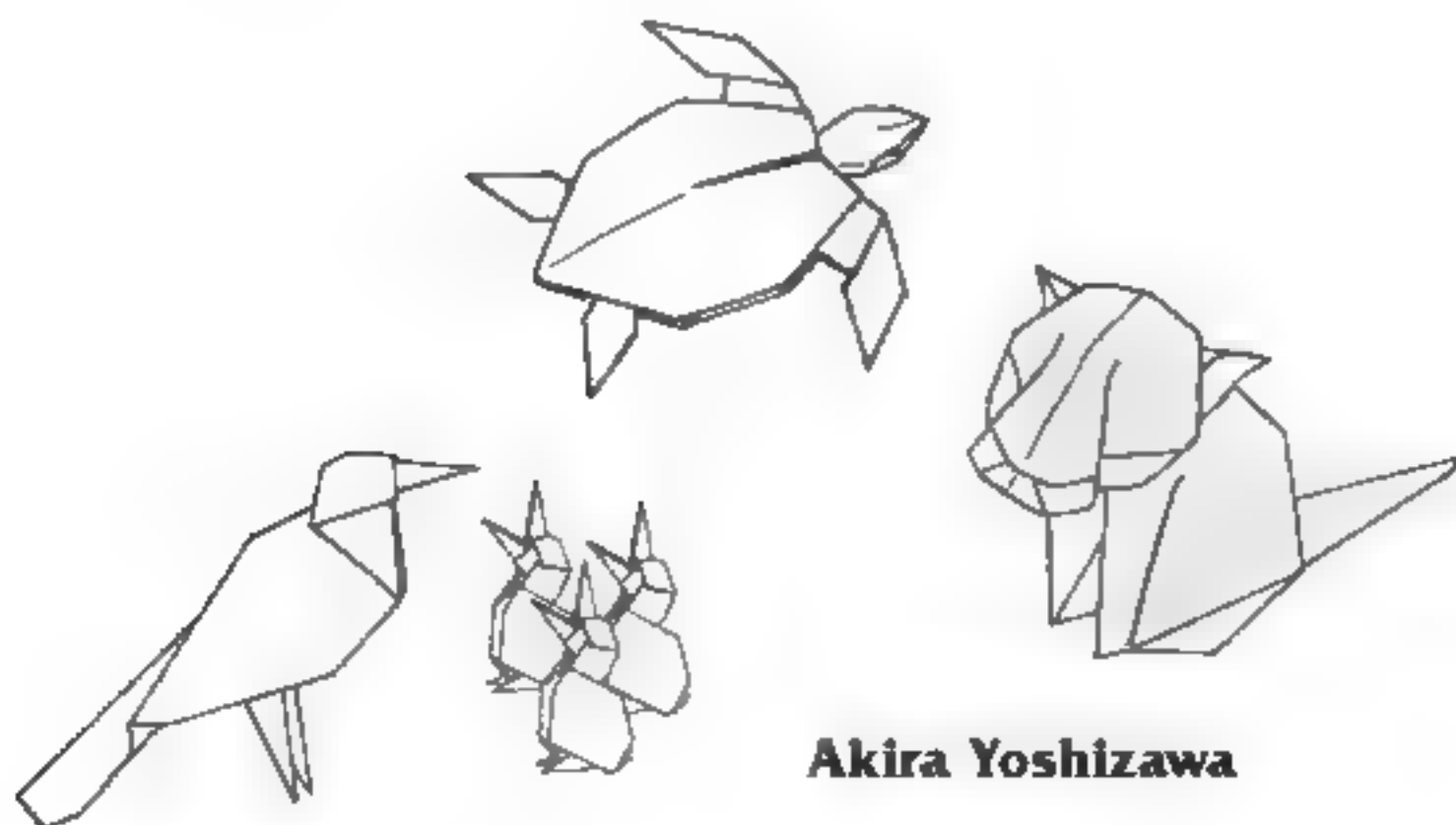
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The surrounding will also affect the experience of the performance. Is it a concert hall or is it outdoors. Are the people around in pleasant or annoying. Is the hall well designed with comfortable seats, or is it noisy and uncomfortable. Is the music a live performance or a recording? All of these elements are extremely important and have a profound effect.

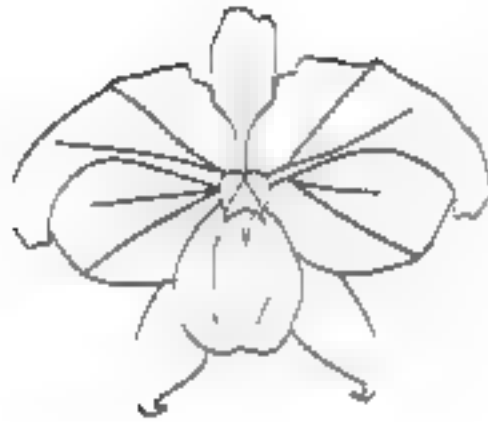
The next question might be "What would be considered good origami from an aesthetic point of view?" This, as with all art forms, is mostly subjective. The popular creators all have their own styles and have incorporated their own esthetic into their work. Consider the work of three creators who are heavily affected by eastern culture: Maekawa whose lines are heavily influenced by the esthetic of popular Japanese culture and are resonant of the Japanese "Noh" plays as well as the visual appearance of their comic book media. In contrast to this approach there is the work of Yoshizawa, who retains the same form of stylization but evokes a lyrical joy to his work and captures its life spark. Larousse on the other hand approaches his work in a similar way as Yoshizawa, but also brings to his work a more Western perspective and background in biology, and while his models have the same spark of life, they seem more like photographs of the subject than stylized illustrations.



**Iun Maekawa**

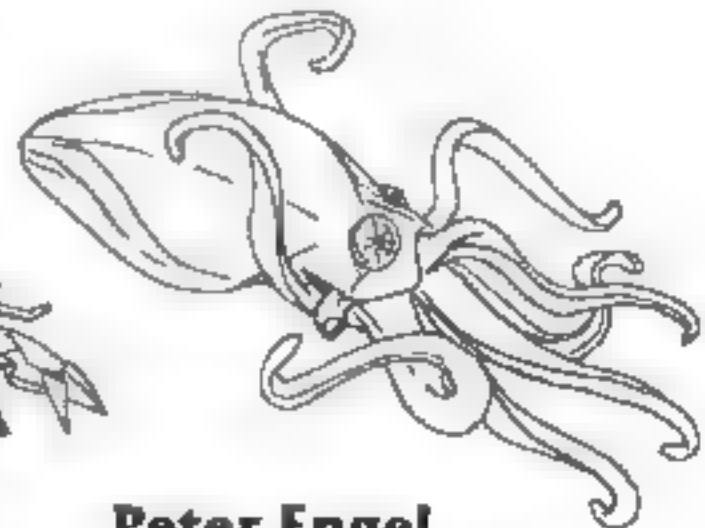


**Akira Yoshizawa**



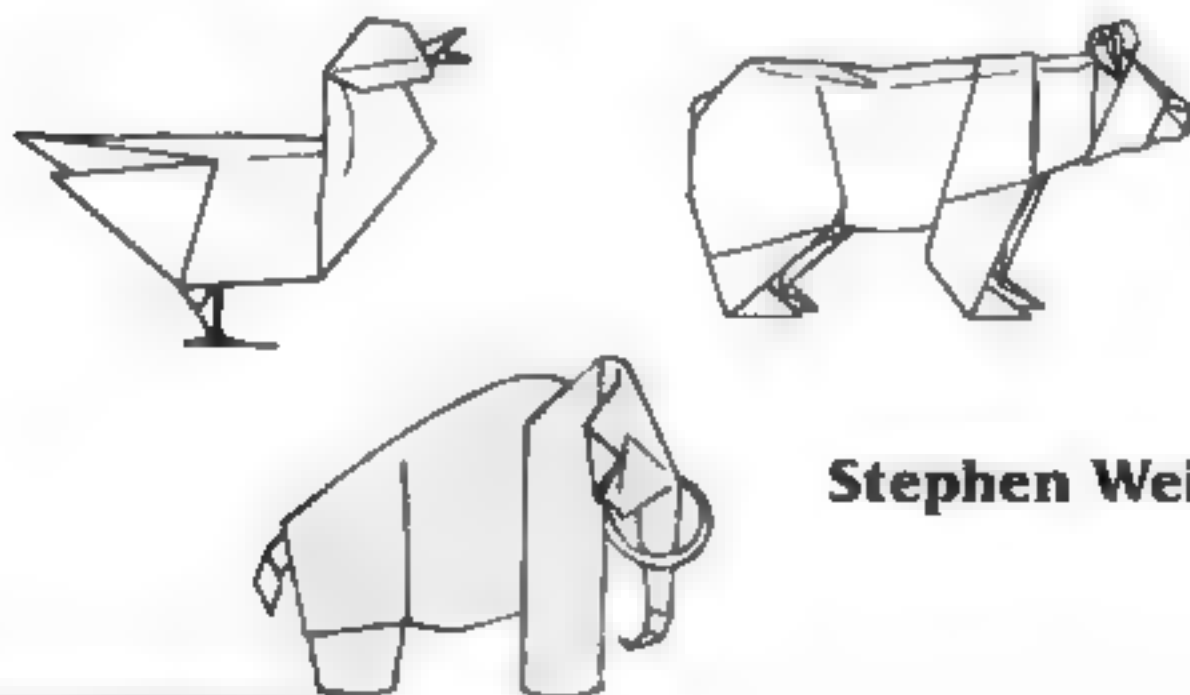
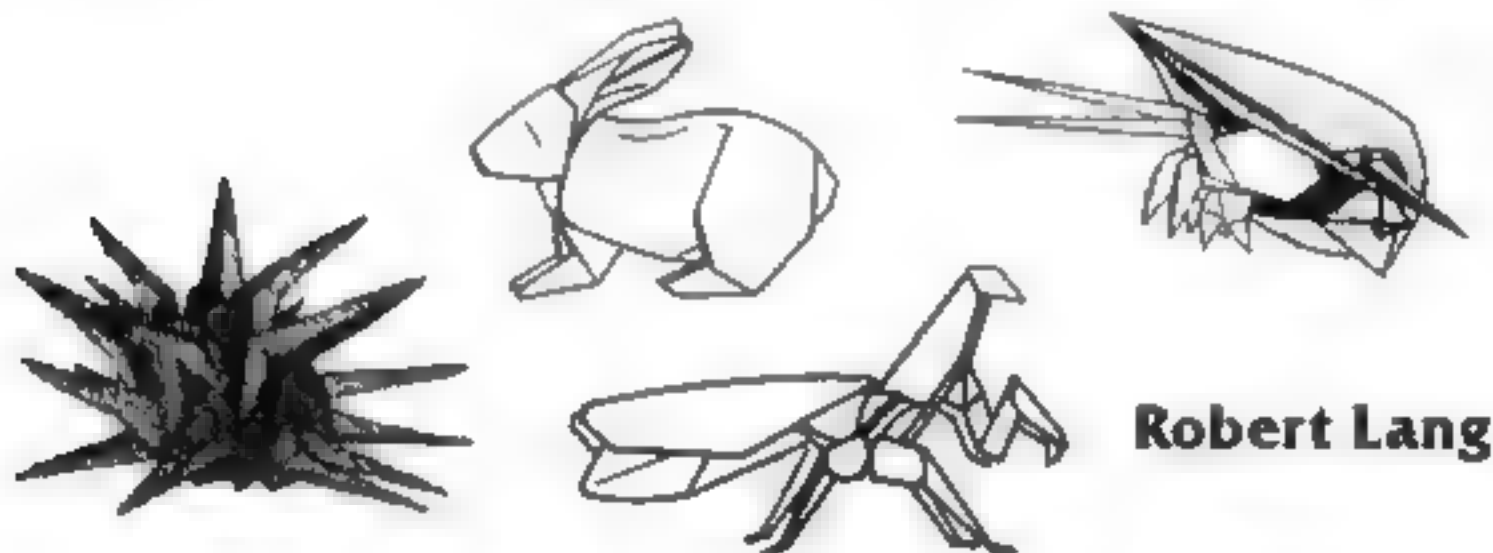
**Michael LaFosse**

In the West, huge variation can also be seen among creators. For example, Engel, whose work is superbly detailed but still evokes a sense of lyricism. Or Lang, whose technological approach heavily seeds the appearance of his work, uses this tendency to his advantage, invoking a sort of technological futurism, a part of its motifs which evoke visions of atonistic cybernetic organisms. Or Weiss, whose work retains much of the stylization and lyricism of eastern organic, but speaks clearly with the western approach towards realism and biological accuracy. With these individuals as with others, a consistency can be seen in the way the image is sculpted, in a way, designing organic models is similar to writing a piece of music. And as with music, there is much more to it than simply throwing a bunch of notes together. Many



**Peter Engel**

decisions and technical issues must be addressed. What notes can be used together without dissonance? What instruments sound pleasant, or dissonant, together? What instruments best set the mood that you are trying to convey? How many layers of sound are desired, should the overall effect be forceful and solid or gentle and dainty? The process of origami design is similar. How should the model be approached? Will it be extremely detailed or stylized? Will it utilize complex procedures or will it be easy to fold? Will it originate from a square or will a rectangle be used? Will cutting be allowed? Will it require foil or extremely thin paper? All of these decisions must be weighed (either consciously or unconsciously) by the creator during the design process. And as with music, all of these decisions are just to the viewer. Only the creator will be able to appreciate fully what went into the design of the model, and only he or she will be truly intimate with the work. And also as with music, the folder will have a deeper appreciation, understanding and intimacy with the piece than one who is simply looking at the finished work. As with music, "it's better to play a piece of music than to listen to it, it is better to write a piece of music than to play it," for doing so allows the experience to experience more of the entire artistic experience. Because much of it is inside the model. There is a lot of art in origami, and in designing you get to experience every aspect of it, but you don't have to if you don't want to! You can simply appreciate the art, or you can do the folding and choose the materials. Or if you are inclined, you can choose to design, and with designing take part in all aspects of the artistic experience.



1 John Cage

# A Natural History: The Creator's Diary

## Introduction

The purpose of this section is to give the reader a sense of my own personal experience of creating each of the models included in this book. I write this not to give specific analysis of the precise structure and formulation of each model, but rather to take a snapshot of the circumstances surrounding the creation of each piece and what I learned from its construction. I do this in hope that I may convey the diversity of experiences that one is likely to encounter while creating as well as the numerous divergent directions in which origami design is likely to take. Some sections are long and some short. Some are filled with technical information, some sparse and unspecific. A diversity reflecting the creation process itself.

## Beginnings

I was introduced to origami by my grandmother during Christmas of '74 when she gave me my first origami book "Origami: A Step-by-Step Guide" by Robert Harlan. I took to paper folding like a duck takes to water and started deciphering the models included within. I managed to fold the simpler ones, but never progressed past Crawford's scorpion, which terrified so many times, knowing my fate. Later that summer while vacationing with my grandmother, she gave me a copy of Kasahara's "Origami Made Easy". I tried my best and her home with paper creatures, to the delight of her many visitors.

That Christmas my best friend also received an origami book "Secrets of Origami" also by Harlan. His book was much larger than my own, and a fierce competition ensued between us to fold the more difficult models in his book. We spent much of our time folding and were entertained with many models including the "re-birthal" "over's knot" which I was fascinated with trying to unfold without tearing. It's Magic by Fred Rohm, which we never could figure out, and with speed folding cranes, which we could generate a less than half a minute. We also had opportunities to teach folding to our classmates.

I think that soon after that we both lost interest in the hobby, probably because we had managed to fold everything that we were capable of folding, and because, with the onset of puberty, there were other pursuits which became more enticing distractions. I've always remembered some models like Crane, the Waterbomb, the Lotus Knot, which I would fold on the rare occasion that origami came up in conversation. Until, with those few exceptions, I didn't put any attention to it for the next 15 years.

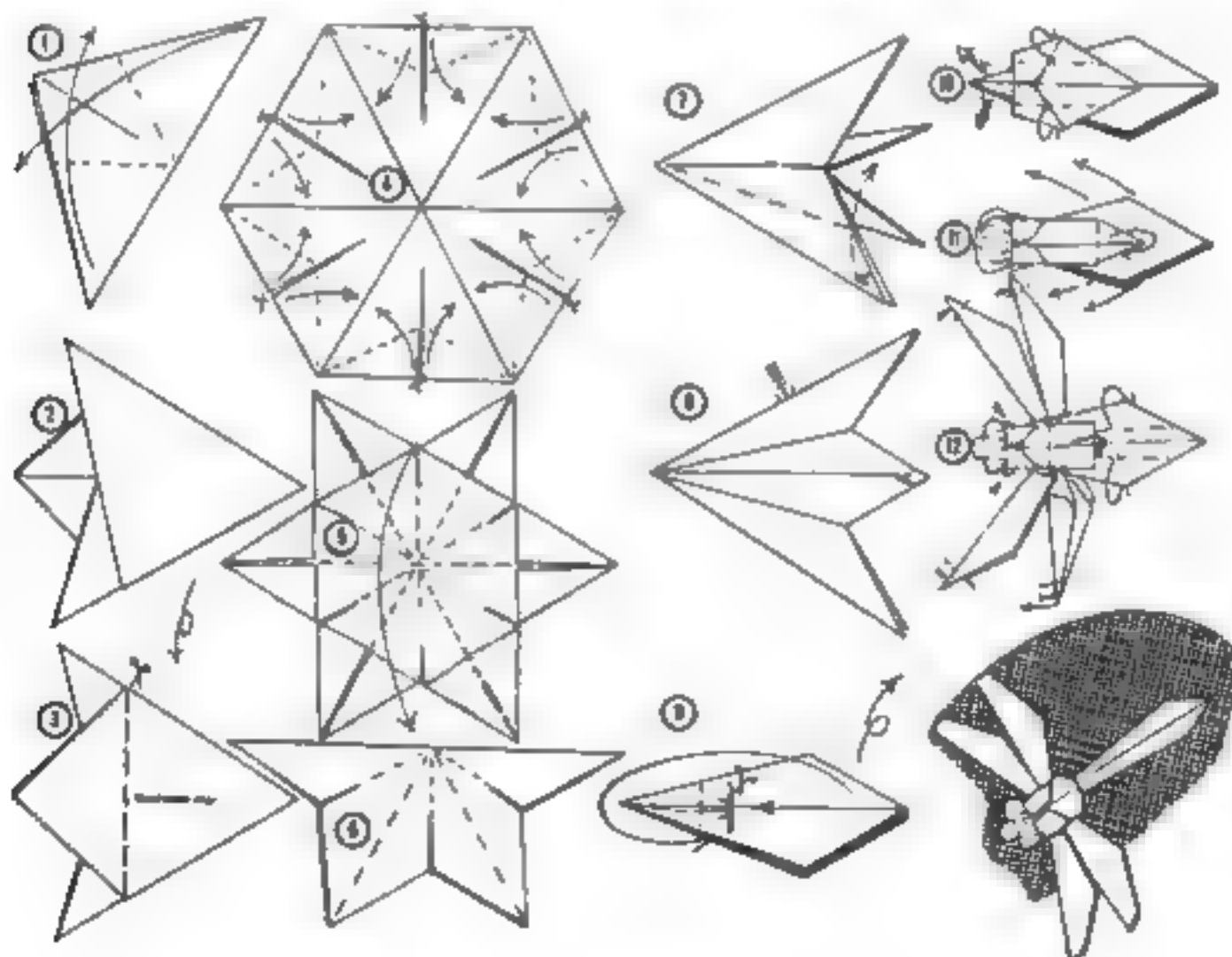
## Resurgence - Sept. 1991

Ironically, the thing that distracted me from origami as a teen was the same thing which rekindled my interest in it during my mid-twenties. This occurred when I was introduced to Natasha, a friend of my friend, at a party. She was wearing small modular earrings created from a model by Kasahara, her idol, and I asked her about them. She told me that she had a side business making miniature origami earrings and proceeded to fold my the delights for me: cranes, a Persian cat, and a modular wreath that can be turned into a star. It was enchanting. I reflected afterwards that I very much enjoyed meeting her and being reexposed to folding and decided that I would like to get to know her better and perhaps spend some time folding together.

After meeting Natasha I was intrigued by the models I had seen and the concept of folding in miniature. I became infected with the idea of folding Crawford's Unicorn in miniature. I figured, "If it's possible to do with Cranes, why not Unicorns?" So, again, I pulled my old origami book off the shelf and proceeded to do so, using tweezers and a V piece of paper which produced a model just slightly larger than my thumbnail. I was amazed with the result and even though I had been the one to fold it, I couldn't believe how it actually existed. It was so small and dainty. Every time I looked at it I literally had to laugh. I was so excited with the result that I decided to go to the library to see if anything interesting had happened in origami in the last fifteen years. What I found was that a revolution had occurred.

At the library I discovered many books including "Prehistoric Origami" by John Montroll and "Origami Sea Life" by Montroll and Robert Lang. These books and many others contained models of incredible sophistication and complexity. Lionfish, sea urchins, Chesapeake Bay blue crabs, Stegosauruses, mermaid models which were inconceivably complicated compared to those that were available to me as a child. I took out as many as the library allowed and got to work, folding everything that I could, and yes I could fold them all! I was thrilled, I was excited, and I was back on my feet and running. But after my initial burst of enthusiasm I was not sure how to proceed. I tried miniature and discovered a revolution and the accompanying plethora of new material. What direction was most interesting to me? I decided to go back to Harbin's "Secrets of Origami" and see if there were any other interesting models which had never been available to me. This decision inadvertently led to my starting to create original models, and ultimately to writing this book.

In the book there was a model of a dragonfly which originated from the seventeenth century. Upon completing the model I was quite dissatisfied with it. The final product seemed quite vague and required many cuts. I always been profoundly intimidated with the concept of creating original models, but in this case I thought that I could do at least as well without cutting. Three months and eight original models later I completed my Dragonfly. But by then I had a grander goal in mind: writing a book that could assist novice designers in their attempts to create. Now, a mere three years and twenty-two models later, I reach the end of that task, knowing much more than I ever imagined possible.

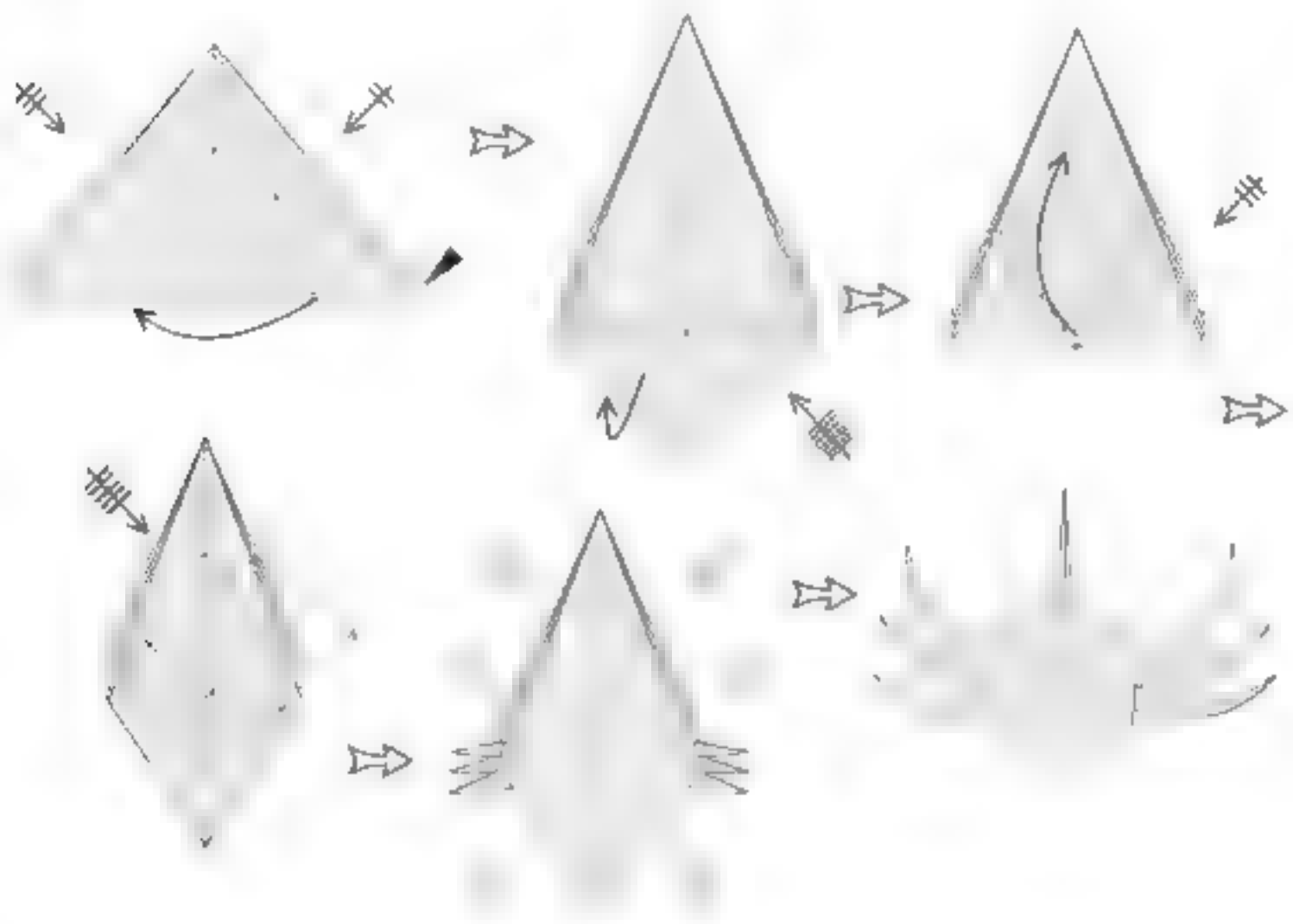




## Horseshoe Crab, Comp. Approx. Aug. 15, 1991, Intermediate

The Horseshoe Crab was my first original. It was created in approximately thirty to sixty minutes at one sitting. I can't say much about how. It happened by accident while doodling with a piece of paper during my early attempts to create a Dragonfly. As I saw it, the most important element of the dragonfly was its head, which had been created in the original mode by folding up the center of the paper like a fan with many small folds and then tucking it through a slit that had been cut in the paper. I thought that if I could start by creating that structure, the rest of the dragonfly would follow easily. It didn't, but the horseshoe crab did.

The structure of the model is conceptually simple. The path of the doodling went like this: start with a waterbomb base, squash fold the points, petal fold the edges, reverse fold the resulting points, then and sculpt the model.



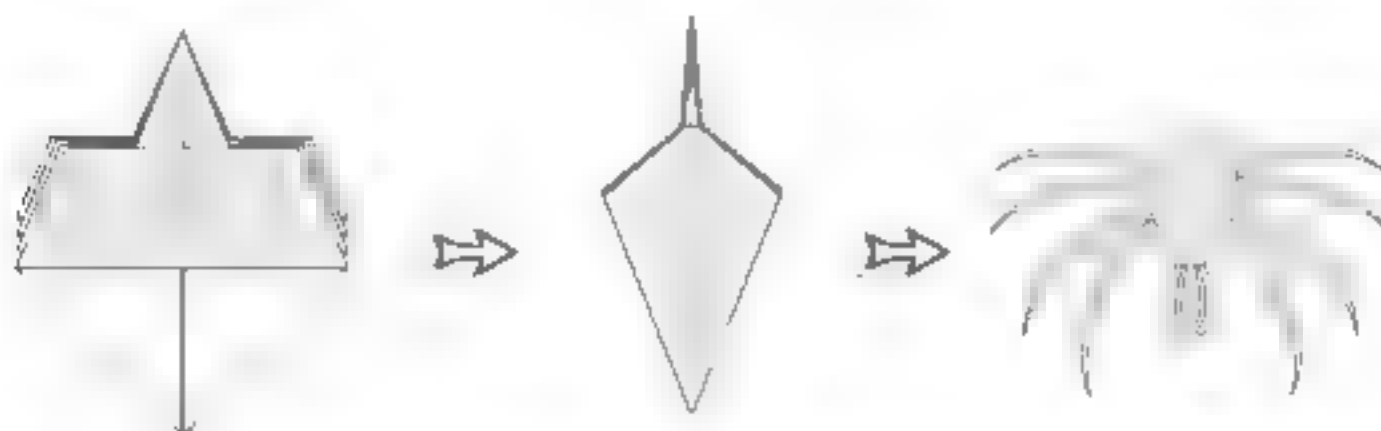
No thing fancy, just a logical progression of applying the same step to a particular model and seeing what you come out with. The final sculpting is where the creative element comes in, and with this model I was. I sure what I had created. If you positioned the tail one way, it was a crab; if you positioned the tail in front, it was a bug. To decide which it was, I took a poll at work. The crab won and thus completed my first model.

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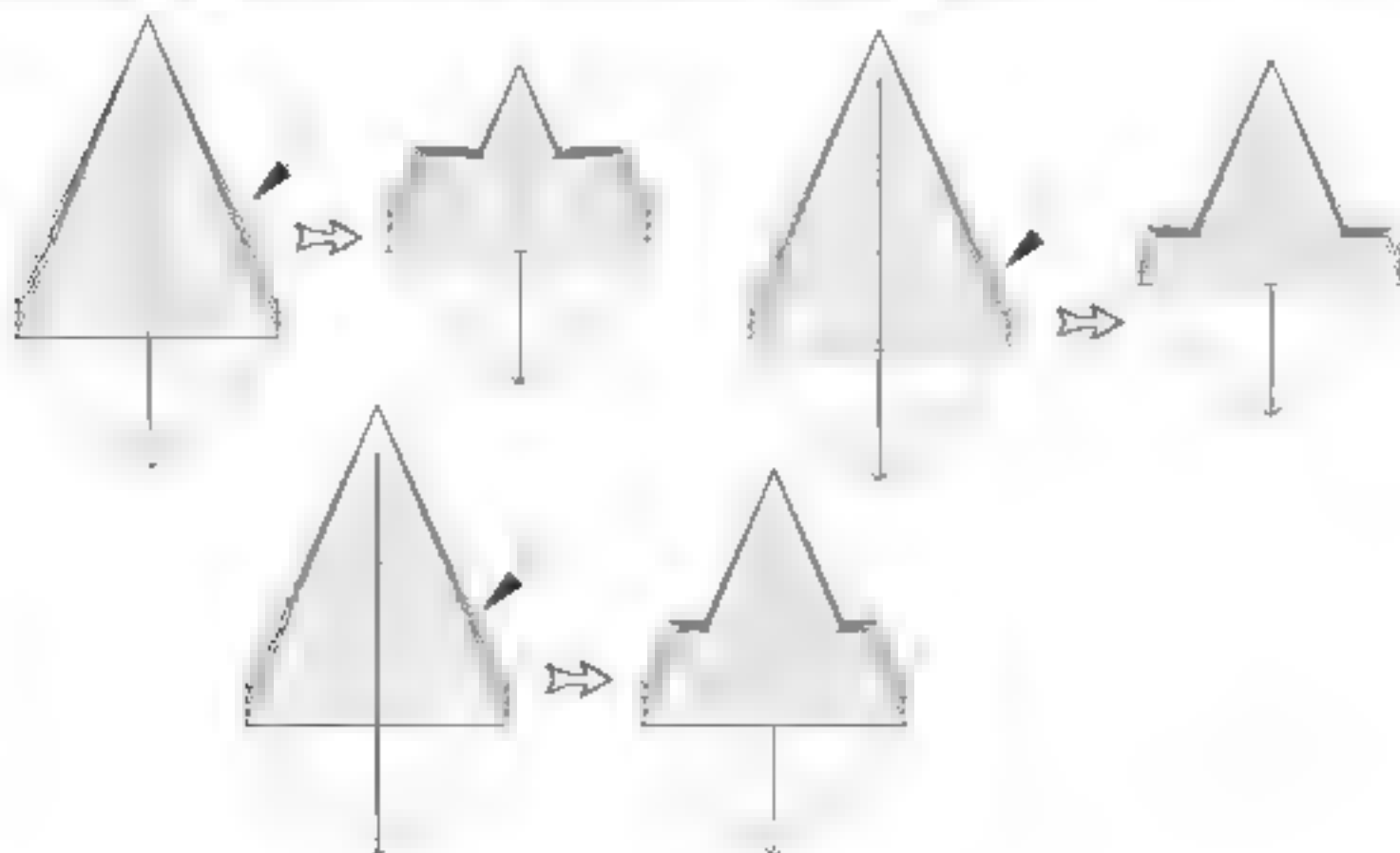
The first time I created this model the petal folds were actually much more complicated and with the edges, the paper wrapped inside themselves, but in the process of trying to put the model into a form that could be described, it is with its design that the approach.

## Wolf Spider, Completed approx. Sept. 2, 1991, Complex

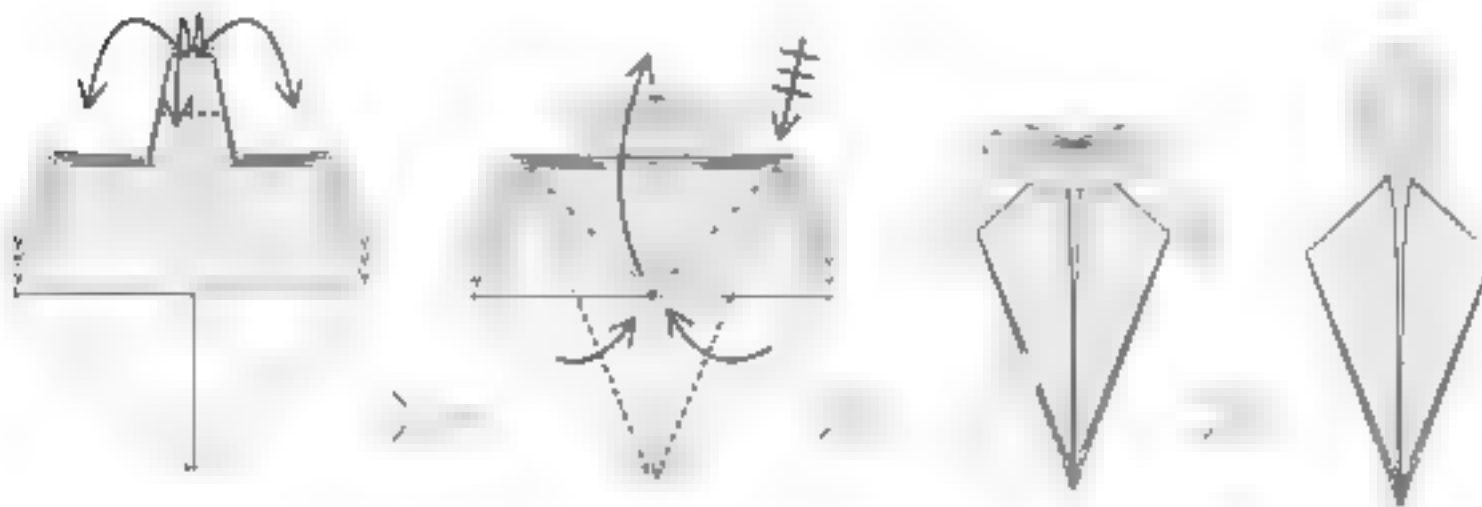
This is one of my earliest models and, in ways, somewhat inelegant, but works fine if the proper medium is used. Like the horseshoe crab, I created it accidentally while designing the dragonfly. I was endlessly intrigued by the form of the Dragonfly's base, which was later dubbed the spider base, and created the first version by executing double petal folds on each of its flaps. But there were problems with the model. Specifically, the thorax, the round part at the back of the spider, and the length of its legs. I found that when I showed the model to my friends, they interpreted the back end as the head and declared the model to be some sort of alien.



To address the problem, I decided to manipulate some of the base variables, specifically, the two creases which defined the proportions of the crimp-sink. I noticed that varying the location of these creases caused the base to take on different shapes, so I started an analysis of precisely how the base was affected by various changes. To test the different configurations I used the same approach that I used in testing the original model: precrease, fold the base, and execute the double petal fold on each side. I started by moving the upper crease. I found that if I raised the crease, the thorax area became smaller and farther lowered it, a larger thorax was the result. Varying the lower crease affected the length and proportions of the legs. Unfortunately, I also found that in making the thorax larger, I was no longer able to accurately execute the double petal fold which produced the legs. Distorted legs resulted.



I had found a solution to the thorax problem, but had caused another, legs of differing lengths. This time the solution came to me from out of the blue, after several days of failing to address the problem logically. I realized the problem was not a lack of paper from which to form the legs, but rather, that the paper was not in the right place. If I could somehow drag the paper to where it was needed, I could correct the proportions. I realized that if I were to sink the pleated point in half, I could easily move the remaining paper to where I wanted to. Similar to the way an inchworm moves, first scrunching up its body, and then stretching it out in a different place. Once the paper was moved I was able to execute the double petal fold. The rest followed easily.<sup>2</sup>

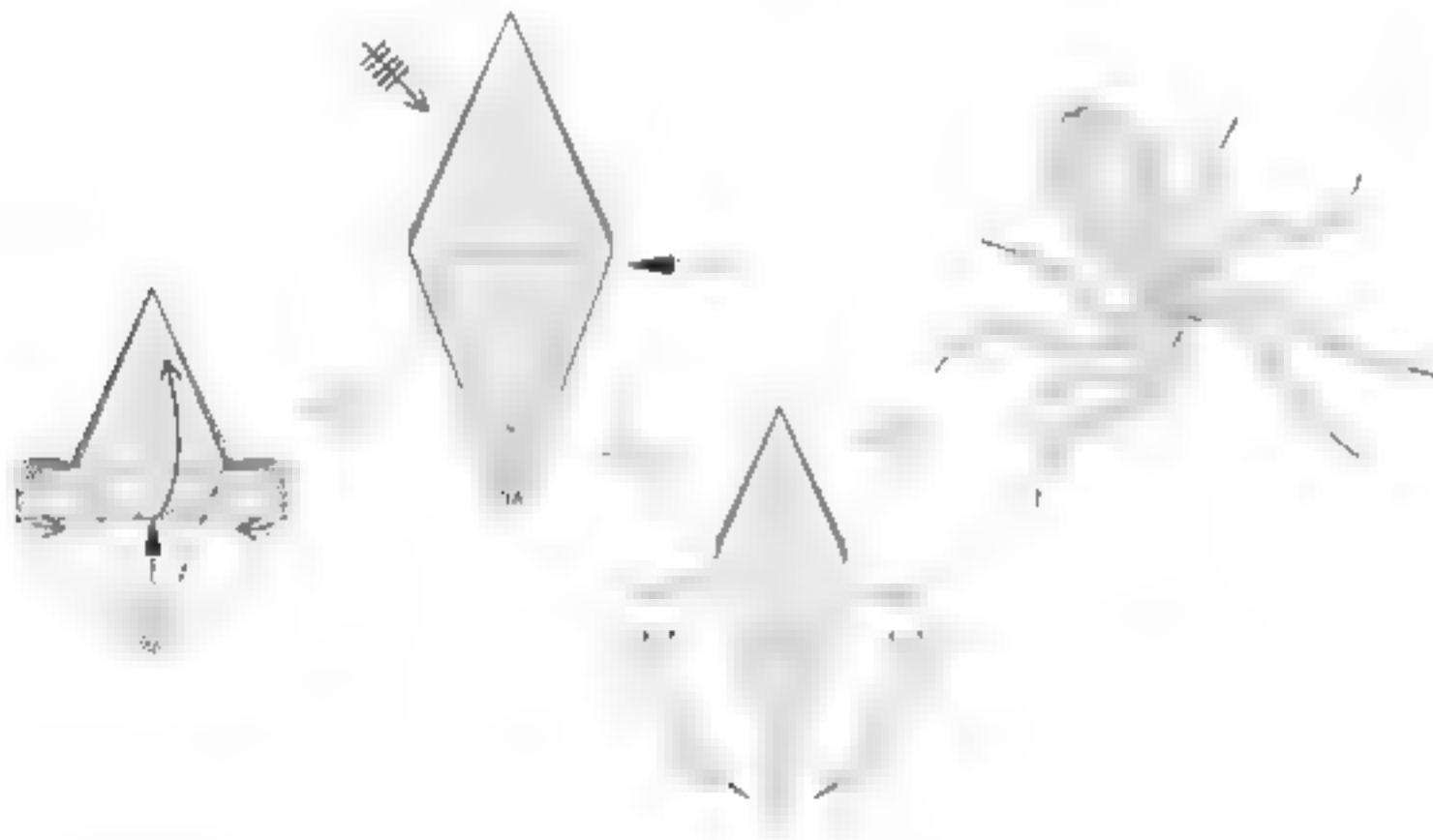


After completing the first version, it was not clear to me what kind of spider it was. My cousin—I have been terrified of spiders, and my general reaction to seeing one is to move on, be replaced, and get on as quickly as possible—I thought it was a wolf spider, but was uncertain. So I went to the library and got out several books on spiders. It was hard to force myself to even touch the books much less read them, but I learned a lot. I discovered that the wolf spider (or common garden spider) is actually the *Larantula* Lycanthorina, and some of a whole family of web spiders (the *Larantula* family, that are so named because they eat wolves<sup>3</sup>). I also learned that the small protrusions I had included in the thorax of the model were not fangs but pedipalps, miniature legs which are used as manipulatory devices. As a result of all this study not only did I have a greater knowledge of spiders, but found that I am now much less afraid of them. Now when I see a spider, I take a good long look at it and can identify its various parts. I am not over-enthused in finding one or anything, but it's nice to not get an adrenaline rush when I come across one.

1. Of course, all the diagrams are an important part of the problem solving process. Because the more time you spend the more you know about the problem. If anything you have learned a way that will not work and perhaps why it failed.
2. The two small protrusions at the mouth of the spider were also an accident. After completing the first version of the model for one instance, I realized it was too small and pushed in some tape so that it was wider. The final tape was designed with some easily fold protrusions, but had no use as we had done so and had little left that would be able to enclose it. Actually, I didn't even know that I was doing this until the model was disassembled and found that it was actually quite simple, a variant of a square and a sink.
3. A particularly vicious spider that tends to grow much larger where I live and seems sadistic in measure, showing up at the most unsuspected times, like one night when one dropped in on me in my bedroom while I was going to sleep.
4. Just kidding.
5. Pedipalps are also much larger in males than females, one way of determining gender in spiders.

## Octopus, Completed Approx. Sept. 21, 1991, Complex

My octopus is another model which is based on variations of the standard spider base. I discovered it while I was experimenting with the ratios of the spider base in attempts to create a larger thorax for the wolf spider. The model was conceptually simple: spider base, raised configuration, double petal fold, sink the sides, sculpt. That I put it aside and never bothered to take any notes. Over the months, I became nervous that I might actually forget the model, omitting some subtle aspect or sequence of steps, such as the folding procedure for the double petal fold. In fact by the time I got around to diagramming the model, I had forgotten the double petal fold sequence and had to recreate it. But in the process, I learned that the octopus is nearly identical in structure to the tarantula,<sup>1</sup> which meant that the new double petal fold sequence that I had created for the octopus could be directly applied to the tarantula. This was a great discovery because I had already gone through two iterations of diagrams for that part of the tarantula, and people still couldn't fold it. After incorporating the new folding sequence, that part of the tarantula ceased to stump people.



One interesting aspect of the model is that the legs are not all the same length. This problem is corrected in the tarantula with additional, if somewhat painful, steps, and if one wanted to, one could apply those steps to create an octopus with all of its legs the same length. This type of intentional distortion is a common device used by artists to enhance their work. It adds variation to the piece and is not likely to be noticed by the viewer, except upon close examination. In this case, I think that it really works quite well because in a paper model of an octopus if all of the legs are the same length, they tend to get in each other's way when you curve and sculpt them.<sup>2</sup>

<sup>1</sup> Excepting that the tarantula has two more legs and an additional step, which makes them all the same length. In fact, the models are logically identical up to step 21.

Another spectacularly detailed octopus can be found in Engel's *Folding the Universe*. This model is also very simple structurally based upon a simple quadruple rabbit ear applied to a waterbomb base.)

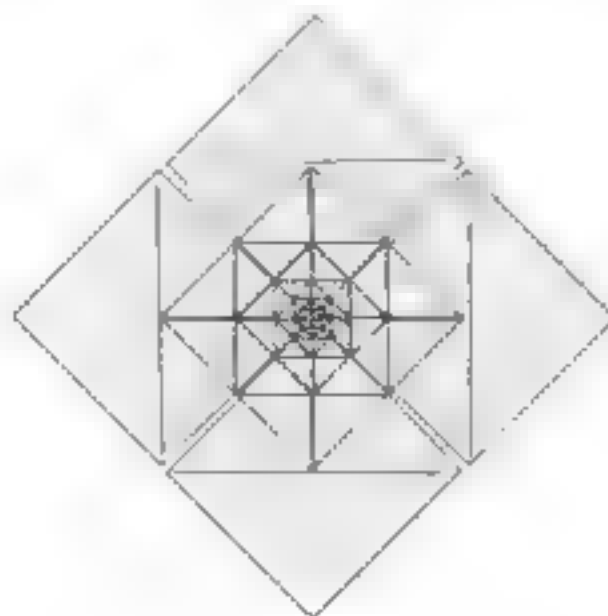
## Andrea's Rose, Completed Sept. 25, 1991, Intermediate

Andrea's Rose is another very simple model. I created it in a matter of a minutes during an informal and particularly boring meeting. While someone was droning on and on endlessly about something or other I picked up a piece of 8 1/2" x 11" paper, tore on the edge to make a square, and started folding mindlessly. My paper, following its own will, was folded into a windmill base, a base with which I am intrigued, and then sunk on each of the four corners, creating Muntroll's moth base, which I had recently discovered and thought was interesting. Sinking one level was so much fun, I thought I'd try another, and then another. I was like eating potato chips. I just couldn't stop. That's how the first model was created.

Several months after creating Andrea's Rose, I discovered Toshikazu Kawasaki's Pinecone in Kasahara's "Organic for the Connoisseur," which is basically identical to my model. At first I was surprised and alarmed, but I have since learned that it is common for the same model to be created by two different persons, independently of each other, especially if they are structurally simple, as is Andrea's Rose. It is interesting to note that our final interpretations of the form of the model are very different. While Toshikazu Kawasaki chose to create a more organic, three-dimensional form, I left mine in a more geometric state, exploring instead the mathematically recursive aspects of the model.

Since the model consists almost entirely of sink folds, I thought it would be a good model for teaching purposes, to instruct novice folders in how to execute sinks. Sinks are often a stumbling point for folders, and I remember that as a child I would shun all models which contained them. Actually, sinks are generally easy -- you know the proper procedure for executing them. I kept this in mind when I diagrammed the model, and I chose to emphasize the correct method of sinking, so that novice folders could use the model to increase their confidence. And so it has been. I've left several folders kicking and screaming through the first several layers of sinks to have them discover that after they say "I'm deeply scared of the paper" (this usually happens eventually), if they were to start over with a new piece of paper, the sinks that they had struggled with the first time around would now be trivial. With practice, the model, and all its sinks, becomes easy for everyone.

So, who is Andrea? She was one of the individuals at my office to whom I would show my new models, and she was always complaining that my models were "gross" since they were "in bugs and craps and such." She asked why I couldn't create something nice like a flower or a puppy. I thought that the model looked somewhat like a rose, so out of sarcasm, I dedicated it to her.

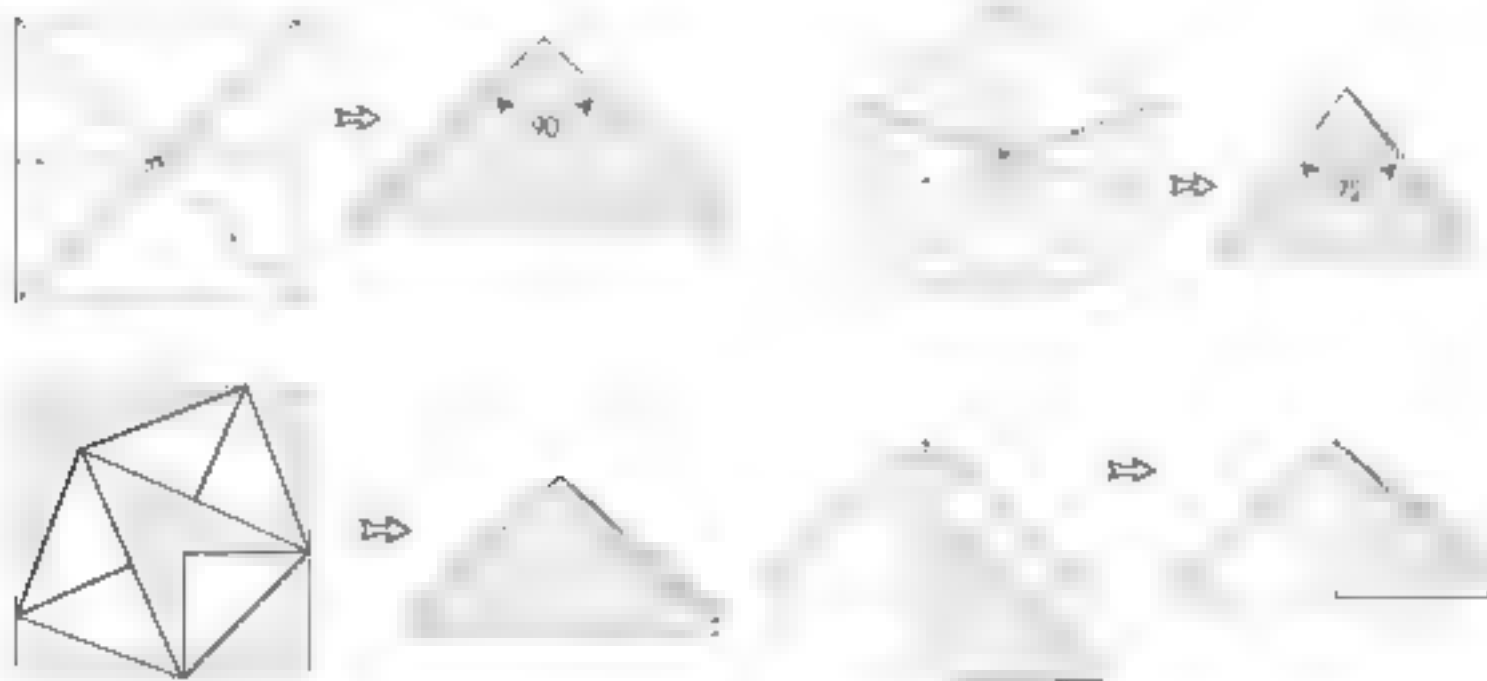


## Tarantula, Completed Oct. 15, 1991, Very Complex

Creating the tarantula was thrilling because it was the first model that I deliberately decided to design and then successfully completed.<sup>1</sup> After designing the Wolf Spider, I became intrigued with creating a spider with an even larger thorax like a tarantula. I did this by further adjusting the ratios of the spider base and then applied a 'sink-and-drag' procedure similar to the one used in the Wolf Spider to allow all the legs to be the same length.

The first version was created rather easily, but it had only eight legs; a tarantula appears to have 10.<sup>2</sup> This is because their pedipalps (small manipulatory appendages near the mouths of all spiders) are so large they appear to be an extra pair of legs. To overcome this problem I was confronted with the task of creating a spider base with ten legs, and I proceeded to become obsessed with creating a spider base from a pentagon rather than a square. I soon learned that working from a pentagon really messed up the ratios of the base, because a "waterbomb" base created from a pentagon does not contain a right angle at the top, because the triangles that make up a pentagon are not right triangles, as they are in a square. What I needed was a true waterbomb base with two flaps and right angles. I knew that John Montroll had created one, and I found his "An Amazing Origami for the Enthusiast," but the base contained lots of extra paper, called "noise," which made it difficult to work with. It seemed to me that it would be better a design with a base that didn't have as much tutz, so I created my first cheater base (by taking an extra flap into a regular waterbomb base), which was what I used for my initial designs.

I am very pleased with this model, and consider it one of my best, in terms of both esthetic and structural design. It can be a bear to fold, but for the confident folder, it is more repetitive than "hanging." As mentioned before, structurally it is very close to the Octopus, and tends to work well when folded from organic high quality tissue paper, such as mulberry or rice paper, which has had a thin backing applied.



1. The dragonfly, my first attempted model, was completed eventually, but only after completing many other models first. The Wolf Spider, which required a great deal of design work, was initially created by accident.
2. Really, check it out on your own!

## Art Deco Lily, October 15, 1991, Advanced Beginner

It was with this model that I came to understand one of the most important and fundamental dynamics in effect while designing. I was talking with a friend who is a non-folder about the structure of the spider base and showed him how it starts off with a waterbomb base and how you squash fold each of the four points. He didn't know a waterbomb base from a squash fold, but being an engineer, he was interested in the application of simple processes to manipulate the paper. I handed the squashed waterbomb base to him and continued talking about other things. While we were talking, he proceeded to squash fold each of the eight flaps on the squashed waterbomb base.<sup>1</sup> Satisfied with the process, he handed the doubly squashed waterbomb base to me and said "OK, I'm done." I took the ball of flaps and without hesitation pinned the sides down and pulled out the model, and handed it back to him, and that was the first Art Deco Lily.

So I really can't exactly take credit for creating the model. My friend did most of the work. But, it *was* created, what is the difference between our roles in the creation process? I was answering that question that I discovered how it is that I create, or at least discovered one way. The model was created using what I call the "fuddling" method (as many of my early models were) where you simply take a piece of paper, dull and uninteresting but ripe with possibility, and mess around with it until you have some abstract set of flaps and points. Eventually, something will spark a vision and you recognize in the model something else, at which point you sculpt it into final form. In the case of the Art Deco Lily, someone else created the abstract form, but I experienced the flash of creativity which allowed me to transition from a ball of flaps into a completed model.

It is this spark which makes the creator an artist, and that vision will vary greatly from one individual to another. If you were to give the same abstract base to a room full of creators and instruct them to create a particular animal form, the variance in results would be astounding. Each artist has his or her own particular vision. In my early iterations, I tended towards biomorphism, while my later models have become increasingly stylized. It is all based in the vision of the creator.

## Australian Leaf Bug, October 19, 1991, Advanced Intermediate

This model is literally the bottom half of my Dragonfly. I inadvertently created it while I was testing an idea for the dragonfly's legs. Structurally, the base of the dragonfly is an eight-flapped, and base with a spike protruding through the top. The approach I had come up with would use double-sweel folds on three of the flaps to produce the dragonfly's six legs. To test the idea, I used three flaps of a regular bird base. The method worked, and after the test I decided that I not only liked the legs, but I liked the test model. My first name for the piece was "kite with legs." Later, it reminded me of an insect, but I wasn't sure which insect I thought that it might be an aphid or stinkbug, but its shape reminded of some strange non-mimicating insects I had once read about in an issue of *National Geographic*. So off to the library went. I didn't find what I wanted, but I did learn that plant-mimicking insects are most common in South America and Australia. That was enough for me, so I decided to make it a fictitious amalgam of insects and name it after a place where they are prevalent. The Australian Leaf Bug may or may not actually exist in nature, but it is as real as any fantasy, existing at least in the realm of origami.

<sup>1</sup> Quite a feat considering we watched many accomplished folders get hopelessly lost in all of those flaps while folding the Art Deco Lily themselves!

2. And even more varied if you didn't tell them a specific subject.

## Dragonfly, Completed May 24, 1992, Complex

This was the one that got me started. It was the first model which endeavored to create. It was not the first that I completed, not by long shot. The idea came to me after loading an ancient dragonfly from the Kanamadu. I wasn't very pleased with the result and thought that I might be able to do as well on my own. So I decided to try.

It seemed to me the model's central element was the head, which was composed of a highly pleated series of folds that came to a point, which was then tucked through a slit cut in the model. I went about trying to create that element of the model first. First, I created a cone from a squashed waterbomb base, and to simulate the tucking of the point through the slit I crimp-sunk the tip. This result was the first spider base. Next, I started peeling the edges, why not, and then noticed that I could peel the flaps back down in the opposite direction. But the point at the tip of the model prevented the edges from lining up cleanly, so I sank each of the traps on the tip prior to the peeling, to lessen that effect. This led to the discovery of my first eight-sided bird base, which is simply a spider base with a configuration that caused the tip to disappear inside the model.

Next came the wings. The structure of the wings is simple, and basically copied from the original model, and that I could integrate them easily, but adding legs was another problem altogether. There was a great disadvantage on the bottom of the model with which to work, that I had no idea how to turn them into legs. It was at this point that I started looking for answers to questions common among novice creators. Such as: "How do you create?" "How do you solve problems?" "How do you keep track of what you are doing?" What I found was that the answers are not readily available, and when I did find specific sources, they were unable, or unwilling, to articulate the answers. It was at this point that I decided to write a book myself. If the answers are not available, then I'll figure them out on my own, and document them. I had known then what I do now, I may have been a little less hasty in my decision.

It was a long time before I actually did solve the problem of the legs and complete the dragonfly. In fact, before doing so, but I created a multitude of models from its base, including the spiders, Cicadas and Caterpillars. But finally, one night while watching a movie with some friends I came up with a way to create the legs, which I tested on a regular bird base, since the base used in the dragonfly was a close to an actual bird base. In fact, the Australian cat flag is the result of that test. I often use that type of approach to problem solving, breaking down problems to simplify them until I can get a better understanding of what I am trying to do. After completing the legs I never bothered to test them on the actual model until it was diagrammed over half a year later.

This model is very difficult to fold well. It is not a bad model, but it was one of my first, is somewhat complicated and crude in approach, which can make it difficult to fold when you don't understand the subtleties of its construction. It is a model which requires practice. I recommend that it not be folded from anything thicker than tissue-fold. Japanese foil might work well, but can tend to be too weak during some of the folding sequences. I've backed it from foil backed kame, and it worked somewhat well, but is quite thick in some places and required much sculpting.

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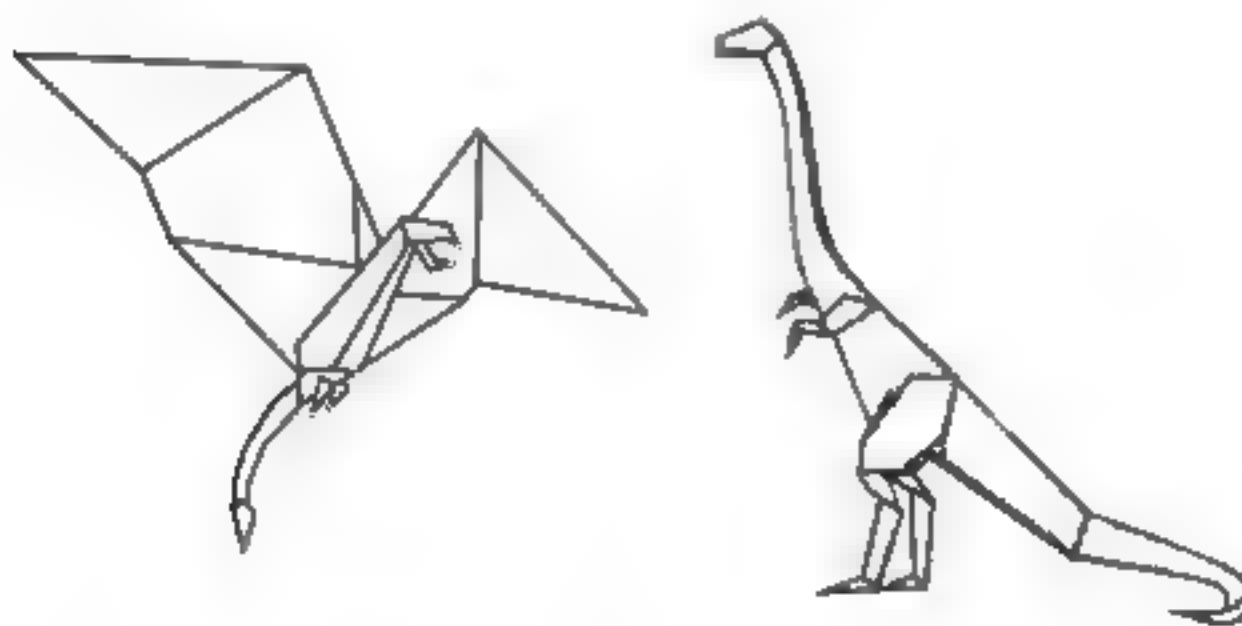
1. For example, while playing, first it is always my objective to make as many even trades as possible, and as the game progresses, simpler I gain the advantage because that is the way that my mind works.



## Hydra, October 24, 1991, Advanced Intermediate

The Hydra is a multi-headed dragon that has appeared in many forms in folklore throughout the ages. When I first created the model, there was a debate in my office about how many heads a hydra actually has, I thought seven was the proper number. But when I looked it up, I found that a hydra can have any number of heads, because when you cut one off, two grow in its place. I believe I may have been remembering the hydra which appears in one of Ray Harryhausen's Sinbad movies which may have had seven heads. Hydras originate from Greek mythology where Hercules once battled one. He killed it by burning the neck of each head as it was cut off.

This hydra is the first of three models I designed in order to have something interesting created from the eight-sided bird base I discovered while designing the Dragonfly. In terms of design, the model is very simple, with each flap of the base being used to create a single appendage, two wings, one tail, and five heads. Structurally, it is a five-headed version of the traditional crane, with some strategically placed slots to allow the wings to sweep backward and some strategically placed sculpturing to make the model more engaging. The head is a slightly modified version of the one used by John Marshall in his *Synanthracis*, and the tail is taken from his *Rhamphorhynchus*<sup>1</sup>, both of which can be found in his book, *Prehistoric Origami*. The approach used in this model is simple enough that hydras with more heads can be created from bases with more flaps. I have created a seven-headed hydra from a ten-flapped base which is created by applying the approach used in folding an eight-flapped base to a five-flapped waterbomb base rather than a four. I've also created a thirteen-headed version from a sixteen-flapped base and have figured out how to create a thirty-two-sided base that would allow me to create a twenty-one-headed hydra, but I've never bothered to go through the process of folding one.



<sup>1</sup> Which is, in my opinion, one of the best origami dragons I've ever seen.

## Taarakian Dragon, October 10, 1991, Advanced Intermediate

The "Taarakian Dragon" is the most accidental of all my models sort of. It was actually created twice. First through doodling and then recreated through a combination of reverse engineering and algorithmic experimentation. The first version happened over the course of several months. During this time I had been developing various models and often used scratch paper to try out one particular fold or another. For example, I planned to use a double swivel fold for a particular part of a model. I might try it on another piece of paper first to see if it worked in the right direction or if I was going to execute a particular type of sink, I might try it on a scratch piece of paper first. In the case of this model, there was one particular piece of paper that had been sitting on my table for weeks, and I had executed this fold or that fold on it while working out the specifics of the Hydra and Australian Leaf Bug. At one point I picked it up in a very quite similar to step 4 and thought that it looked quite close to a dragon. With a few quick sculpting tools, I completed the first version and tossed it back onto the table. It was after all just a doodle and I had no thought that it might be worth keeping. The next day I was showing off my Hydra at work, and someone jokingly asked me if it would fly. Of course "the hydra" couldn't it looks more like a "leafbug" than a paper airplane. Anyway, the doodle dragon on the other hand did look somewhat like a glider so I picked it up and threw it as a joke, and the damned thing flew. I was amazed.

Well, here I had this little dragon that actually flew and I hadn't the slightest idea of how it had ended up. It had been created over a period of weeks with no intention or direction at all. The only thing relevant about its construction was that I had started from a bird case and that it contained a double swivel fold somewhere. I didn't want to unfold the original because I had no confidence but I would do a better model. I thought it likely that its lines were very important to its aerodynamic stability and that if I were to unfold it I might lose the subtle relationships that made it stable. As a compromise, I unfolded it very slightly to see if I could figure out from that point how it had been created. I couldn't so I folded it back and discovered that it would no longer fly!



So what to do? I started over from scratch, using what I could remember from its original sequence of random generation: start with a bird base, execute the double swivel told from the Australian leaf bug, execute two sinks and swing the wings back like on the hydra, and improvising where I couldn't remember. This new version looked the same, but it took me several hours to properly tune the positioning of the wings, head and feet to get the model to fly. But it turned out that the final model is actually more stable than the original, and more attractive.<sup>1</sup>

So what is a "Taarakian Dragon?" The reference is rather obscure. It comes from the film "Heavy Metal." The movie was based on the science fiction magazine of the same title and was broken up into short animated segments taken from different stories that had appeared in the magazine over the years. The final segment in the movie was titled "Taarna" and was about a leather clad avenger who comes to the aid of a civilization of people who had been overtaken by an evil race of invaders who had recently been transformed into ugly green monsters by a flood of green slime which had originated from an alien meteorite called the Naar Stone (no really). Anyway, "Taarna the Defender" was a descendant of a race called "Taarakians" who were, as presumably, daughters of a deity called "Taarak" who rode strange creatures which were sort of a hybrid between a dragon, a seagull and a chicken. If you remember the poster from the movie it depicts Taarna mounted atop her dragon. The original image for the Taarakian Dragon came from the story "Arzach" by Moebius, the great French cartoonist. This dragon is quite resonant. Taarna is mount so I named the model after it.

## A Simple Dragon for Natasha, October 28, 1991, Intermediate

"A Simple Dragon for Natasha" is actually a one-headed variation of my Hydra—designed for my friend Natasha who reminded me to design as an adult with her miniature e-gart earrings. She's always looking for simple models that can be folded quickly and I thought that a miniature dragon might be a good subject. So I designed one for her by taking my original Hydra model and folding it from a four lapped butterfly rather than the eight that is used in the two-headed version. Unfortunately I found that the model is too difficult to fold quickly and so was never used for its original intention. But it is a good model in miniature and produces an excellent, if pointy, pair of earrings.

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<sup>1</sup>The original was aerodynamically stable at high speeds, but at the end of its glide it would slow down and eventually become unstable and tumble.

## Butterfly, November 4, 1991, Intermediate

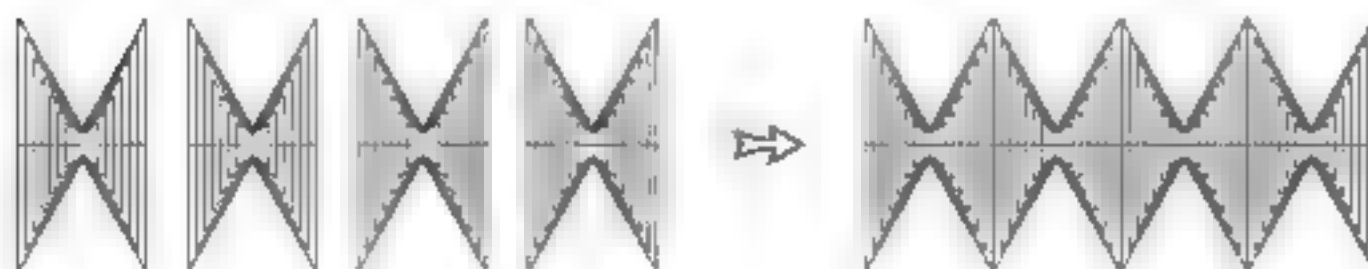
The butterfly was created under the influence of two dynamics. It was created accidentally one afternoon while doodling with a piece of paper, but coincidentally it also addressed my desire to create a companion model to Andrea's Rose which would serve as a good practice and teaching device for developing the mastery of sinking techniques. Conceptually the model is very simple, composed of pleat sinks repeated over and over on a waterbomb base. It works well as a teaching model and I am amused by young folders who are terrified by the model, but after trying, I become very adept at pleat sinking — also became aware using this model in teaching, of an interesting dynamic — to executing the model correctly you must unfold it completely before embarking on each new pleat sink, and then fold it back up, reversing all creases. This instruction has often been met with groans or disbelief from my students. But it made me aware of an important step in the growth of folders, gaining the willingness to unfold a portion of their model in order to be able to move forward. This is particularly true in the case of children who generally desire immediate gratification and expect each step to bring them visually closer to completion. So in creating a model to teach others a skill which often becomes a stumbling block for folders, the sink I gained insight into exactly why that particular skill becomes a stumbling block.

## Butterfly Chain, November 5, 1991, Intermediate

The butterfly chain was my first inspired creation. I was lying in bed one night with thousands of thoughts floating through my head (as is often the case) when I made the logical observation that the butterfly and rose, completely unrelated edge, then one ought to be able to chain them together. The next day I found out and was thrilled with both the result and the fact that it worked. For me it was a significant step, because for the first time I was able to envision the manipulation of paper in my mind without actually having it in front of me. Even though the realization is trivial, it is the sort of obvious concept that completely eludes me. I attribute this breakthrough to the additional intimacy with origami which I had gained from having designed several models at my own. This taught me that in origami, as in any other artistic endeavor, skill improves with practice, and while talent has an impact on how quickly you assimilate and apply the skills, it does not determine your ability to acquire and utilize the skills. Or stated more simply, "Practice makes perfect." Anyone can learn to design; it is just a matter of being patient with yourself and putting in the time to learn the necessary skills.

## Delta Glider, November 6, 1991, Intermediate

After creating the butterfly I was intrigued by the concept of applying the same technique to other shapes. One obvious choice was to start from a triangle, so I did. Later someone mentioned that it looked like the shanghai number. I considered the idea and agreed, and after having accidentally discovered the "Farkas Dragon's" aerodynamic stability, I wondered if my new piece wouldn't fly. It did.



1. Which is necessary in many intermediate and most complex level models.
2. I have since discovered that there are several excellent books which have wonderful examples of similar manipulations.

## Cerberus, December 23, 1991, Complex

Cerberus, the mythical three-headed dog which guards the gates of Hades, originates from Greek mythology. This was the second of three models which I designed solely because it had eight appendages, and easily led itself to being torised from an eight-sided bird base. I was thrilled upon completing this model because it was, as far as I knew, the only representation of Cerberus in the origami genre—unfortunately I was wrong. Four months after designing it, I discovered a version by Robert Lang in the newly published “Mythical Beasts” by Jay Ansil. I was quite disappointed, but I’ve since learned that the development of similar models, in terms of both subject matter and structure, is commonplace and for many, is the cause of great dissent and suspicion.<sup>4</sup> Luckily, in this case, my version of Cerberus is extremely different from Lang’s, both technically and esthetically. His model is based on a modified version of Moritani’s dog base and has a very stylized look, while mine is based on a bird base and takes a more sculptured, western approach.

In terms of approach, Cerberus was a mishmash of analytical, inspired and algorithmic design. Structurally, it is very similar to Crawford’s Unicorn. They are both constructed from a stretched and base-the-anal starter, in exactly the same way, and the technique used for bringing the heads into position is very similar to the unicorn, right down to the color changes (steps 16-19 on the Unicorn, steps 45-50 on Cerberus). They are different enough to say that my Cerberus is based on Crawford’s Unicorn. It is probably more accurate to say that I was inspired or influenced by her work and naturally applied her techniques.

While working on this model, I ran into a problem which I was afraid could not be solved—the color change which is executed in steps 45-50 to eliminate the white paper on the neck and heads. It is I guess, intimidating to me to have to deal with these sorts of challenges, but somehow a solution always appears. Enough sometimes you have to put the entire project aside for awhile, perhaps several months, and an answer comes. In this particular case, I’d spent hours and hours wrestling with it, and somewhere, as yet to be brought fully to mind, a solution, at which point I quickly put this model down and went to bed. The next day, I can no longer remember my solution and had to find another way at that point I started taking notes as I designed, rather than relying exclusively on step-tolds to find my way.

With the exception of that scare, the design of the model was uneventful. I did put a great deal of attention into the sculpting portions, because I thought it was unique and wanted it to have a very nearly high degree of realism. I spent hours at the library researching dogs to select the proper mix of attributes and decided on a Rottweiler for the body and a Greater Swiss Mountain Dog for the heads. During the final sculpting and diagramming steps I kept illustrations of those animals nearby.



Rottweiler



Greater Swiss Mountain Dog

### Three heads, four legs and a tail

- This model is the only one from that series requiring the unusual eight-sided bird base defined in my studies base.
- When a model reaches the level where he or she is able to comfortably create complex models in subject areas in which one’s interest has been awakened, it is only a matter of time before the model is created. This makes original ideas a precious commodity, and for some, leads to an intense sense of secrecy and competition for others. It leads to an openness and embracing of the collaborative spirit of a group. I tell somewhere in between being open with my models and diagrams once I have shown them publicly, but keeping them close to home until that point.

## Stylized Pegasus, December 26, 1991, Advanced Intermediate

This is the last in the series of models created for the eight-sided base. Since so many models of Pegasus already exist — decided to try and design one that is easy to fold, which led naturally to a stylized design. It probably took no more than an hour to fold the first one. Its design is relatively straightforward: the tail is a simplified version of the one used in Crawford's Unicorn; the head is the same as a flapping bird's with the proportions changed slightly, and the legs were slimmed slightly to make it more esthetically pleasing. I considered using more detailed head and tail constructions, but preferred the simplistic look of the model as it is.

## Loch Ness Monster, Exact Date Unknown, Advanced Intermediate

I've included this model at the suggestion of a friend. Originally, it was an experiment that came upon one evening while I was fantasizing about what I might find someday when I embarked on creating a dragon. As I was fiddling with the paper the model just sort of happened and I kept it as an example of how I might put teeth on a head which has been created from a single point. I never considered the piece to be a complete model, but several months later I found it again and wondered if I might not create a simple dragon from it. A friend suggested to me that it was fine as a minimalist model, and that I should include it as is. And so I did. It is sort of fun, shows a simple way of creating teeth, and goes well with a diving duck which is also a water model which is not complete unless it is sitting on a table. And so, here it is, in all it's modest splendor.

## Braided Paper, February 13, 1992, Advanced Intermediate

The braided paper was a glorious accident. It fell upon me while working on the Frost Dragon, which designed using the "Piecemeal" approach where each part of the model is created separately and then "glued" together to create the final product. I had created various parts of the model: the feet, the wings, the head. It was from one of these parts that the braided paper emerged.

I had created the head of the dragon with its horns and beak intact from a single bird base, and was attempting to come up with an approach to create a single square from an arbitrary surface of paper. I felt that if I could create an arbitrary square and then form a bird base from it, I would have a way of integrating the dragon's head with the rest of the model. Analyzing the problem, I thought that if one were to take a square of metal and attach it to a metal rod, one could then wrap a large sheet of paper around the end and create a square surface with a lot of extra paper underneath. Logically, if one could do that with a wire, I thought, then there must be a way to do the same thing with a piece of paper. My philosophy being that if the paper can be squashed and molded into place, it can also be folded into a discriminating as don't know if there is a sloppy way, then there must also be a logical one.

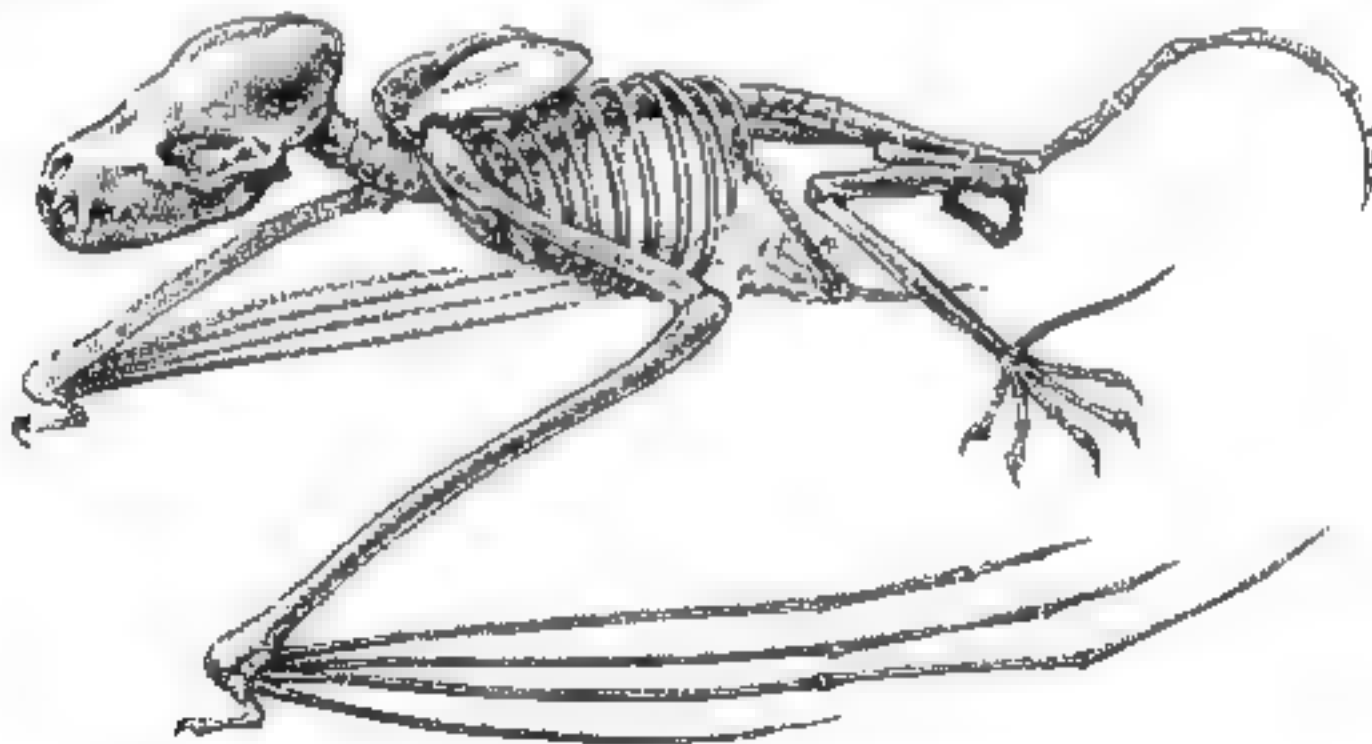
In trying to find a logical approach, I started with the windmill base, because it seemed already to be close to what I was trying to accomplish. From there it was a task of taking the extra paper and trying to use it in a logical fashion, which I did. I had gotten as far as the step where I had executed the pleat, stuck prior to the rabbit ear construction's step 24, but was not pleased with the feel of the base or the thickness of the spires going out to the corner, and while playing with it I spontaneously braided the flaps together out of frustration, because they were getting on my nerves and I wanted to get them out of the way. I never really considered it a possible model until a friend saw it and decided it was her favorite of all my creations. Well, who am I to argue with my fans? So here it is, serendipitous accident that it is — Oh, and by the way, I never did use the isolated square approach to implement the head of the frost dragon. I discovered a better method using quadruple rabbit ears soon after completing this model.

<sup>1</sup> Later, I was very pleased to find the same teeth on a model of a rabbit, created by one of my original students. The algorithm is so simple that, in return, it's been used by others in other places, out loud, in my and I came up with the approach without any prior knowledge of it.

## Frost Dragon, February 5 - March 9, 1992, Very Complex

I love mythological creatures, all sorts, but two of my favorites are dragons and unicorns. I suppose this feeling is common among creators because there is no lack of models of either. I've seen many unicorns that are wonderful, Crawford's Weiss's, Montroll's, but I've never seen a dragon folded from a single sheet which encompasses everything that I imagine when I think of a dragon. But because this model was so important to me, I'd decided to wait a few years before attempting one, so that I would have available to me the arsenal of skills I thought I would need in order to create a model as complete as I wanted. Unfortunately, that strategy was undone. I was devastated when I discovered Matthew Green's "Long Tailed Dragon" in the 1990 FOC A annual collection. It was everything that I ever wanted in an organic dragon: long tail, upper/lower jaw, large wings, etc. When I saw it I was looking at the dragon that I'd always wanted to design, and I felt that I could do no better.

But after folding the model, I had one small criticism. If one considers winged creatures which exist in nature (excluding insects), they all lack forelimbs. This is logical if one considers the skeletal structure of these animals: for in each case, the bones which would have been their front limbs have been replaced with the structures which support the wings. The bat, for example, has very long, spindly fingers with webs of skin between them that form its wing. Birds have a similar kind of hand/arm structure within their wings. If this is the case in existing animals, then if a dragon were to exist it would most likely be subject to these same rules of morphological structure. This means that the wings would be located near the spine of the animal, where the shoulder blades are the same as in other animals. In Matthew Green's Dragon the wings are up the "thorax" of the model, away from the shoulder blades.<sup>1</sup> This is of course a very tricky critique, but it was at least something to inspire me into not giving up entirely on creating a new model.<sup>2,3</sup> So that night I started playing with wings.



- Of course, there is also in nature no lack of models of animals with six limbs (excluding insects). One who is in a straw man, his argument, then a dragon would have such forelimbs like a bat. But even literature has always been helpful in this regard.
- 1. I agree with Robert Lang in his opinion that if a model has been implemented extensively that there is no room for "wing" to critique at all. If a model is able to reproduce all the following processes of construction, then it is a model. If a model is simple, has not been aesthetically there is nothing to be achieved, then you are better off putting your effort into a model which has yet to be attempted in that way (continuing to expand the horizons of organic forms despite you will never reach the living "reality" of a Black Forest Cuckoo-Cluck (I promise!)).
  - 2. This is assuming that you are an accomplished designer. Otherwise, it makes sense to create whatever strikes your fancy because all practice is good practice.

As a starting point I chose Peter Engel's Butterfly because the positioning of the wings in the model is perfect and analyzed only the portion of the model pertaining to them. I ascertained they were created by taking a modified waterbomb base and twisting to form a unit between the flaps. Using this approach I was able to create a base form which I created an interesting Angel, but it didn't seem to be the right direction for a dragon. Next, I analyzed Matthew Green's Dragon's wings and found that they are structurally very simple. I chose to combine the two approaches which led me to the method used Steps 66-69. This gave me the model's first element, the wing structure and the Frost Dragon was on its way.



After creating the wings, I started working on other portions of the model. First I designed the head, in an inspired few minutes, from a bird base. Next I was faced with the problem of trying to integrate this head with the existing wing structure. I spent a long time trying many approaches and all were unsatisfactory to one degree or another. I recalled Robert Lang doing something on an arbitrary flap of paper to make a bird-like construction in one of his Origami Sea Life models. I looked it up and discovered that he had used a quadruple rabbit ear which turned out to be the solution. Next I created the foot which like the head can be folded from any isosceles right triangle of paper.

The Dragon's tail came next. Adding a tail was simple in that it was clear to me the paper was to come from another flap of the waterbomb base, but actually executing the folds was an ordeal because I wasn't sure how to get the flaps positioned correctly. In my early attempts, I tried to form the tail from paper to the side of the wings and then pull it into place, designing asymmetrically. I took this approach because the wings had already been created side-by-side and I considered them an integrated unit. After some struggling, I got the obvious idea of placing the tail between the two wings and redesigning how the wings integrate. This much more straightforward approach was successful, although positioning the tail into the proper location remains somewhat of an ordeal Steps 69-84. The model now had wings, a tail, a head and a neck, and paper from which I could create the four legs. The only problem was that the head and neck were nowhere near where they should be with respect to the rest of the model. To solve this problem I had come up with an elaborate way of collapsing the model to reposition the structures. This procedure appears in steps 90-96.<sup>1</sup>

<sup>1</sup> My attempts to do so led to the accidental discovery of "Braided Paper."

<sup>2</sup> This fold is quite similar to the hands and such that are used in Jun Marukawa's lay designs, but created by virtue of not being exposed to his work. It has not been my tool used anywhere else, but it is simple enough that someone somewhere must have also discovered it.

<sup>3</sup> Which was greatly simplified in later versions of the model.



By this point, my original waterbomb base had grown to an eight flapped version, with each flap representing a single major element of the model: two for wings, four for legs, one each for the head and tail. The final step was to integrate the legs with the rest of the model. But by then I had spent so much time struggling with various aspects of the model that I did not have much enthusiasm left and I executed these steps were executed with little interest or effort. This was my first piecemeal model. The integration process can be very frustrating and intimidating, because it is never clear how to approach and there is no guarantee that it is even possible.<sup>1</sup> During the design process, I used over 100 separate pieces of paper, which I'd stuffed in a bag, and taken twenty pages of handwritten notes on the folding process. I'd also created step folds, but I didn't expect to have to use them.

By the time I got around to diagramming the model, several months later, there were several aspects of the model that I didn't like. First, in designing the original I'd forgotten to give it a body. Because of this oversight, the dragon had a stubby body which made it look somewhat like a horned bulldog with wings. I also felt that leg steps were not detailed enough, that the procedure for creating the tail was too vague, and that the collapse that aligned the neck was much too complicated, and therefore difficult to diagram. I also made another heart-stopping discovery. You see, the model had been designed using a cheat: a base wherein the base is made by taping extra flaps to a standard waterbomb base, but if the model were executed with a folded base, extra layers of paper would appear that broke the texture of the wings. After all that work, wasn't sure the model could be properly folded at all! So as I diagrammed, I started to take time, and basically, the structure of the model was entirely reengineered from step 8 to 9. Since these changes were derived as I diagrammed, I had only one model from which to work. There were no step folds, and was not taking any notes except that I was diagramming as I went. Since the model was so wrong, I'm sure, I did all the modifications on a single working version as I diagrammed. Accordingly, there was no room for mistakes, and little leeway for experimenting as I redesigned the final folds.

To address the problem with the model's dog-like appearance, I started adjusting its ratios. I long hated the neck, and changed the size of the head from 3/8 to 1/2 a flap, to 1/3. I used the variation by taping scraps from different sized pieces of paper (1/4, 1/8, etc.) and superimposing them on a completed dragon, and I found the size that I liked best. I reengineered the approach for folding the tail and executing the collapse, greatly simplifying both. And after some experimenting I came up with the modified version of the eight-sided base that appears here, which resolves the wing problem.<sup>2</sup> Ultimately, I am pleased with the model, though in its final version I have allowed it to take on a "stuffed doll" appearance, because when I've continued to implement final sculpting steps on the legs, but this additional detail can be easily added at the folder's option. Now, in retrospect of two years, I feel I can improve on the model still, and this dragon will probably not be my last. In fact I will probably be designing dragons for as long as I am folding.



<sup>1</sup> Though I suspect that a mathematical proof to the opposite effect could be written, that given an infinitely thin piece of paper, and enough folding, it is possible to do anything.

<sup>2</sup> Yes that's right, designing without a net!

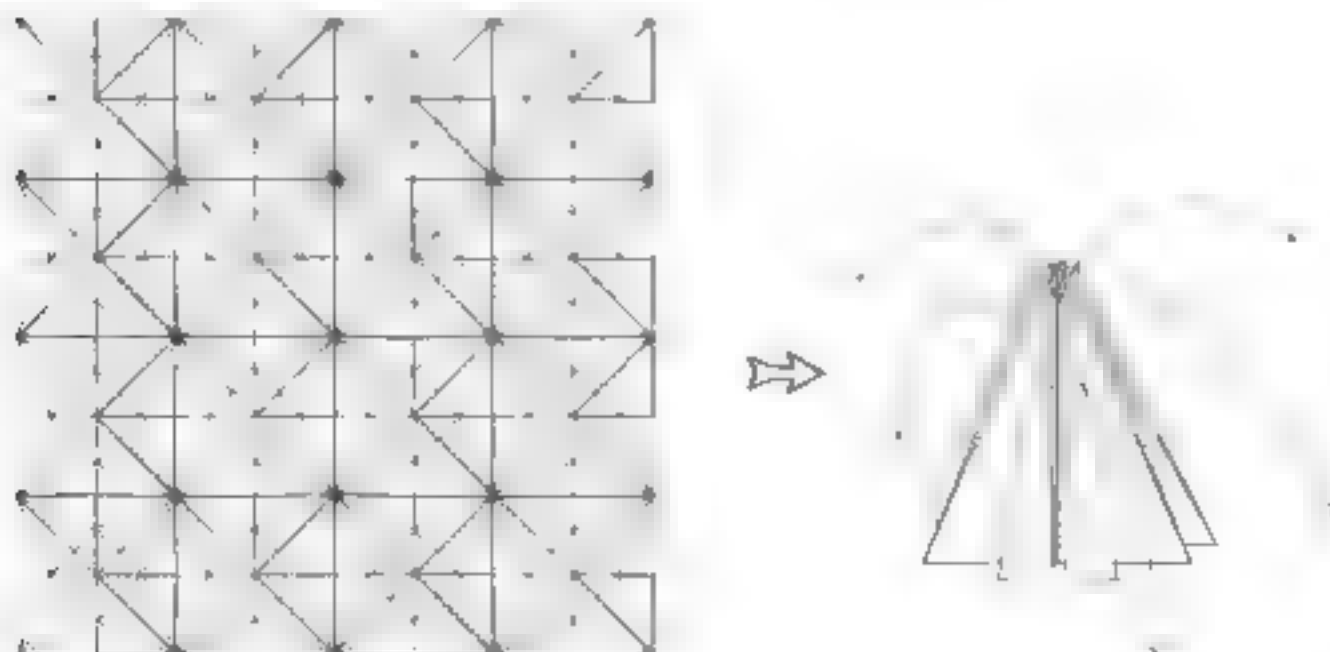
<sup>3</sup> Ironically, the new design was created in transit, traveling to New York for the National Origami Convention in June 1997.

## Clown Fish and Sea Anemone, Very Complex

Anemone, April 9 - 10, 1992, Clown fish, April 11 - June 11, 1992

I am very proud of this piece not because of its complexity but because of its originality. The idea for the model came to me while visiting a pet store. The store had an exhibit of tropical fish and included a tank filled with anemones and clownfish. For the non-ichthyophiles reading this, clownfish, also called o-w-n damselfish, are small tropical fish which have formed a symbiotic relationship with the poisonous sea anemone. Though the sea anemone appears to be a plant, it is in fact an animal with many slender tentacles which are tipped with poisonous stingers. The anemone waits until an unwary fish swims within reach and grabs it, stunning it prey and then consuming it. But damselfish have been able to build an immunity to the anemone's poisons, either by gradually building up resistance or through genetic immunity. Once the fish reaches immunity, from then on the fish will live within the anemone's tentacles, helping it by living up the microbes which keep it there, while the anemone protects the clownfish from predators. In my case, the pet store had a tank filled with several white anemones and many bright orange clownfish which were playfully darting in and out of the anemones tentacles. I noticed that the color of the stripes on the fish were the same color as the sea anemone and thought that the whole scene would make a wonderful model. That evening I started work.

The model was designed using the piecemeal approach, first creating the anemone, which was rather easy and only took a few days, and then the clownfish, which was very difficult and took months. It was while working on this model that I came to truly understand the topological approach to design. Because in the case of the anemone it was clear to me what I wanted to accomplish from a topological viewpoint. I view create a matrix of fixed bases on the paper and then collapse into a disc. This is the most rigorous and effective approach to attempting to create this sort of structure and not surprisingly is the same used in Robert Lang's Atlantic Euphrate Sea Urchin, who is a well known advocate of the topological approach. In fact his and my models are identical topologically, meaning that if you were to fold and unfold them, they would have identical creasing patterns. This is not to say that the models are identical, internally they are different, his are tight and compressed, like an urchin, while mine tends to be more fat and spread out like an anemone.



1 The process of designing models by mapping them out on the paper prior to folding.

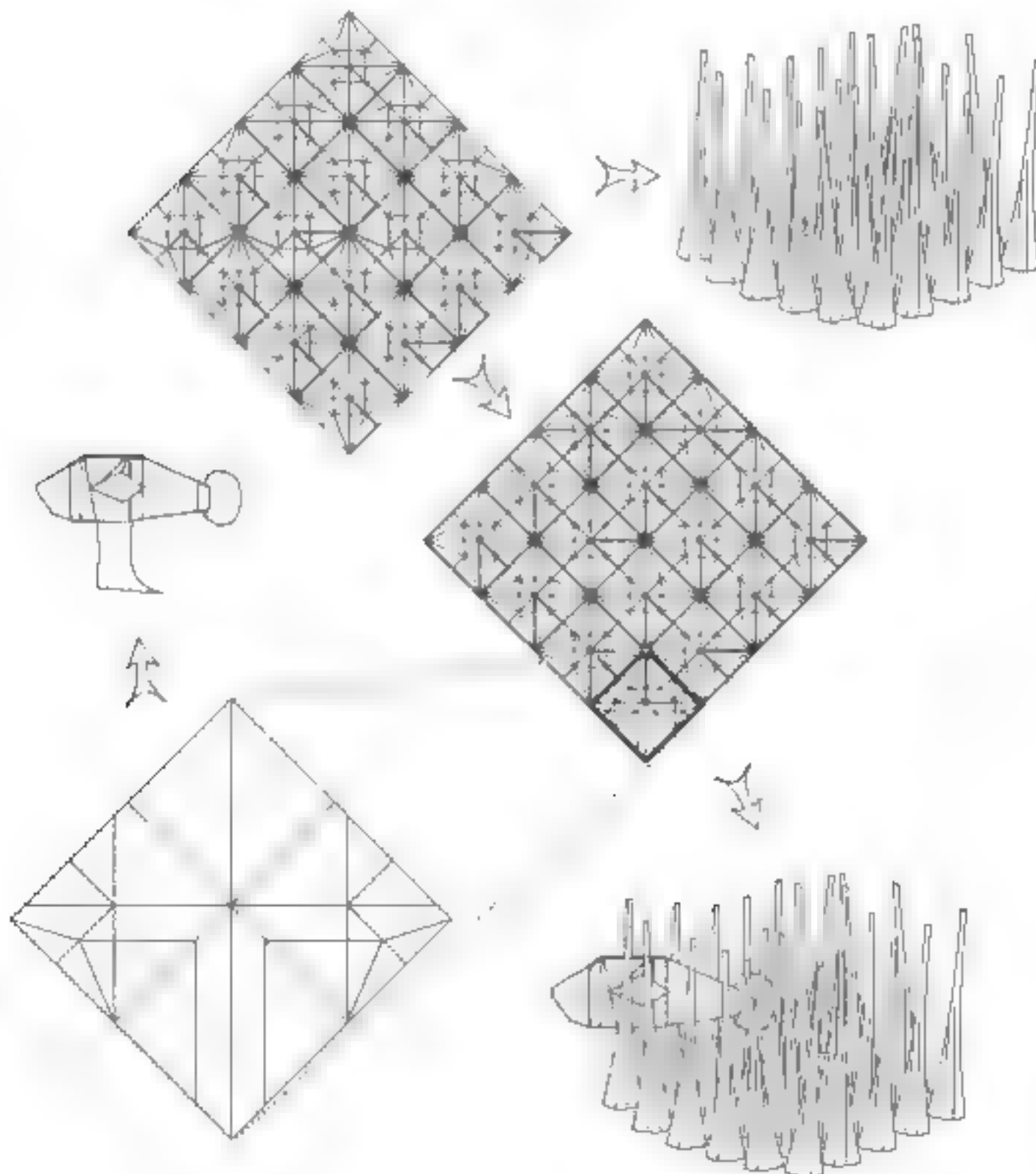
It was through this similarity that I came to respect the profound importance for creators to understand the macro-cosmic view of ungainly and how much easier it is to fold models using that approach. This came to me through an accidental discovery made when I was trying to create the base for the anemone. I was working with the paper trying to collapse the topological array of 16 bird bases and suddenly had a sense of dereliv. I found that through my doodling, I had found Robert Lang's Sea Urchin as the way to step 19 without the aid of directions. I had found Lang's model only once and that was two years prior. I was far from having the model memorized. If one considers the complexity of Lang's Sea Urchin it seems an utter impossibility that one could proceed that far through the model without directions, but it was a very natural and simple thing to do. The reason lies in the power of the macro-cosmic approach to folding and the difference between how a reader looks at a model and how it is approached by the designer. When readers work from diagrams, they view each step as a single entity moving from one fold to the next. This is a micro-cosmic view looking at the folding process in terms of the most minute detail, a single case. The designer, on the other hand, approaches the model in terms of an objective, i.e., "create a base pattern of sixteen bird bases and then collapse it into a base." This is a macro-cosmic view where the process is viewed in terms of objectives rather than in terms of details. Using this approach it is not inconceivable that two readers might follow the same path in their attempts to find a solution to the same problem. In this case, I and I were moving in the same direction, at least for a while. But because of other requirements in my design I was forced to move in a different direction.

I ended up using a completely different approach. Previously I had discovered that a quadruped tablet cut executed on a single flap of a waterbush base would produce two flaps from the one. I decided to use the same approach, or an eight flapper version, which would produce sixteen flaps and two sinks, the sixteen flaps being the bird bases. This approach also allowed me to leave a single flap of the waterbush base uncut, which would allow me to easily integrate the clownfish into the model at a later point. The only remaining obstacle was the four inverted sinks which are executed in the middle of the paper. It was obvious that they were what was needed to create the final spikes, but I was not at all clear how to go about doing them. It was after many failed attempts that I tried executing them up-down as they are implemented in the final directions. My logic was that since the sinks were inverted perhaps they might be easier to execute backwards, since people are more accustomed to executing sinks through mountain peaks rather than valleys, pushing the paper inward from above rather than outward from below. I found that it was easier, at least to the degree that I was able to execute the procedure successfully where previously all attempts had failed. With that accomplished, the final sculpting steps followed easily. Overall the design process was relatively straightforward and took only a couple of days.\*

Creating the clownfish on the other hand was a long and challenging process. The difficulty was in creating stripes. Stripes are one of the most difficult features that a designer can attempt to add to a model, because each time a color change appears the edge of the paper must be present. Of the clownfish's three stripes, the first implemented was the middle, which was a relatively straightforward addition. The first stripe came next and was also relatively easy, borrowing a procedure from Crawford's Full Ripped Ship. Next came concentrated on adding pectoral fins, which was a bit of a stumper. I had been working with creating them from the paper below the body for a long time (step 84) until I realized that there was no paper at the bottom of the fish, it could only fold away to move it into the proper place. After much fiddling I came up with an approach (steps 84-89) which, believe it or not, are relatively easy, once you figure out what's going on. To complete the model I had only to add the final stripe and sculpting to the head. I designed several different approaches for completing it, but the one that is included here was invented during the diagramming process.

- \* Ultimately, after working with the approach, I found that I had transformed my eight flapped waterbush base into a nitzed windmill base, because it allowed the internal bird base creases to be added more easily.
- \* Ironically, the approach used here, demonstrates that the model can easily be modified to be an anemone without a clownfish, and that extra fish can be added with some minor adjustments.
- \* Only one reader completed the design, which is a situation not common during the diagramming/folding process.

Once the fish was completed, the final task was to combine the two parts. This was not difficult since I had designed the model with integration in mind. There was only one problem. With the way that the pieces came together, the early steps of the fish (steps 69-80) must be executed upside down from the way that they were originally implemented. That is, if I were to diagram just the fish by itself, I would illustrate the other side of the paper, because this is the way the original was designed. For this reason, I recommend learning to fold the fish by itself, before attempting the entire model. Another aspect which makes this model so difficult to fold, other than the fact that it is 3D for most of the construction process, is the level of detail on the fish which tends to make the model very thick, especially when working with thicker papers or in miniature. For that reason I recommend NOT trying to fold the model from anything other than tissue for 16" or greater in size until you are familiar and comfortable with the folding process.



## Seven Simple Bracelets, April 30, 1992, Beginner

These models were inspired by my friend Sue Nickles. I had just started work on my Clownfish & Sea Anemone and was starting my first experiments with creating bicolored models. The only striped or spotted models I had ever folded at that point were Montroll's Cow, Camille & Zebra. And while I had a vague sense of some possible approaches, I really had no idea how to proceed.

I had spent most of the night wrestling with creating some sort of striped base, any type of striped base, and after hours of trying, I was just starting to discover how difficult it is to create bicolored models. Later that evening Sue came by, just about the time where my frustration level reached the saturation point. She had never folded anything before, but was intrigued by the problem that I had failed so critically at, and after approximately three minutes of playing with a piece of paper, handed me the Zigzag bracelet.

Several weeks later I decided it would be fun to include Sue's bracelet in the book, but felt that one piece was not enough and decided to create a full set. I chose to include seven because it sounds good with the title "Simple Bracelets." By that point I had completed the Clownfish and was more comfortable with the process of implementing colored models, and designing more bracelets was pretty much a process of playing around with making layers of paper and seeing what came out.

The first task was deciphering how Sue had created the original Zigzag. I did this by unsteering the model and experimenting with fresh pieces of paper until I found the proper crease ratios. It was interesting to discover how much variation was possible in the model by simply changing one ratio slightly. In fact, the final version is slightly flatter or flatter than the original. After engineering the Zigzag, I started figuring to create the other designs. The first was Diamonds, which was followed by all the stages of the Multi-bracelet. The final piece was Horizontal Bands, which was I designed deliberately to complete the set.

## Diving Duck, May 2, 1992, Complex

The idea for the Diving Duck also came from my friend Sue. We were walking with a park near where I live, and were watching the ducks dive under the water to feed on the greens growing underneath. It was interesting to see the ducks move over the surface of the water except for their flailing feet and rear ends. She pointed to one and said "You should fold that..." So I did.

This is the first model I designed entirely in my head prior to folding the first version. The design took approximately a week. I feel that my ability to do this is not a reflection of genius, but rather to the level of experience which I gained in designing all the previous models. I recall a time when I showed Mark Kennedy my "Braided Paper" and he proceeded to tell me exactly how it was constructed, without ever having seen the directions. I was amazed. But again, it was a reflection of his level of experience. In the case of the Diving Duck, although it has some unique and confusing steps in it, such as the sinks, the color change, and the reverse fold toward the end, the model is quite simple conceptually. It is basically a preliminary base with two corners folded downward.

A fun game to play with this piece is the "guess the model game." It is a lot of fun to drop the model on a table in front of a group of people and try to get them to guess what it is. Give them the clue that the model is not complete unless it sits on a flat surface.<sup>1</sup> Eventually, someone has a shift in perception and figures out exactly what it is. Announcing what the model is always gets a good laugh, and of course, once the shift in perception takes place, everybody sees it exactly as it is.<sup>2</sup>

<sup>1</sup> At which point I was forced to beat her about the head and shoulders with a large pillow.

<sup>2</sup> Be sure to say "flat surface" and not "table" or they will get stuck as a wasted turkey and never come up with the answer.

<sup>3</sup> Incorporating the Ah-Ha principle which states that once someone perceives an object (in this case, a model) as what it is, they can no longer not see it for what it is.

## Seven Colored Lovers Knots, Sept. 2&12, Nov.10, 1992, Intermediate

These models were created through inspiration and algorithmic experimentation. The base for the model was created by Russel Cashdollar, a fellow member of "The Capitol Folders," a regional organic group that meets in Washington D.C. Russell is one of the most original and creative designers that I know. His models are unlike anything that I've ever seen or conceived. Such as his Paperoni Pizza, a color change model of a slice of white pizza with colored pepperoni, or his totally hilarious model of Mink Jagger with its many variations, and his alternate very unique interpretation of Santa Claus. At one of the monthly meetings Russ brought in a colored cookie-catcher and I immediately thought it would make a totally wicked Lovers Knot. So I had him teach me his cookie-catcher and that night I folded the first of the colored Lovers Knots by treating his base as a single flat piece of paper. I wanted to include the model but felt that it, like the Bracelets, was too insubstantial to include by itself, and as I was going to be bold enough to make a variation on a model as classic as the Lovers Knot, I might as well make a party of it. So I started experimenting with creating different patterns of colored bases and folded each into a Lovers Knot to see how they would end up. I created several dozen models but only included those which I found most interesting. The Checker was first, then the Spiral, then the Flag then the Multi-version.

## Leaping Lizard, September 9, 1992, Advanced Intermediate

This model was created both accidentally and deliberately. I wanted to try my hand at creating using the topological approach and had a particular subject in mind. To create the model I first did a sketch so that I could study its proportions. Then I mapped it out on the paper and proceeded to condense it into a single sheet. I completed the first version of the model in just under five minutes. It was over a month before I could reproduce the result. During the redesign process I learned a lot about having faith and patience with myself. I was so frustrated by my inability to recreate the model, and was certain that even if I was able to do so, I never be able to diagram it. Because when I created the first version, I pushed and stretched and pulled and literally melted the paper into place. I seemed unlikely that I'd ever be able to create a logical and organized way of folding it. But I've always believed that if there is a way to crush the paper into the desired form, then there must be a straightforward way to do the same thing.<sup>1</sup> Eventually I did find the proper sequence of folds, but found that in some cases the "mushogami" approach<sup>2</sup> produced a better result, and left it that way in the final diagrams. This can particularly be seen in the region of the arms. As for the model, its proportions are very close to the original subject, but it lacks the detail that would make it recognizable as what I wanted to create in the first place.

## Fairy, September 8, 1993, Complex

This model was inspired by a rose vase full of tines created by Yoshitaka Kimura which I saw at the '92 National Organic Convention. I loved the form of the model but wanted to create a version from a single piece of paper. It was created primarily out of frustration. You may have noticed that an entire year elapsed between the creation of this model and the Leaping Lizard. This was because I had devoted all of my extra time and energy to my book, forsaking other artistic endeavors such as painting, sculpting, music, and designing original models. One night I was in a particularly foul mood and felt a need to prove to myself that after all this writing that I could still create, so I started doodling. I created the first version in a approximately forty minutes. First came the base, which was a logical progression from a sunken bird base, and after pulling the side flaps upward I saw the form of the fairy hidden within. From there it was a process of forcibly sculpting the model into the first crude version. Once done I put the model aside but saved a copy of the base. It was several months later when I picked up the base and folded completely in my attempts to recreate it. So I put it aside. A few weeks later I tried again and the model came easily in its present form which is much simpler than the original version.

1. Assuming that you do not tear or distort the paper in any way while doing the "messy" version.

2. And can be found reprinted in that year's "Annual Collection"

## Paper Folding, the Last 2,000 Years

Paper has existed in various forms for thousands of years. Today's modern process of creating paper from wood pulp is claimed to have been discovered by the Chinese in 105 A.D. Paper was later brought to Japan in the sixth century by Buddhist monks, where it was embraced by the Japanese culture. The beauty and elegance of origami forms was revered by the Japanese and origami models were integrated into many of their stylized ceremonies. Unfortunately, paper was an extremely rare and expensive commodity and was only available to the most affluent. It was not until many centuries later that paper folding became available to the common people. The earliest known books on the topic are the "Senbazuru" "How to Fold One Thousand Cranes" (c.1791) and the "Kanomado Kayaragusa" "Window on Mid-water" (c.1841). It was around this time that the term "origami" which is formed from the Japanese words for folding ("ori") and paper ("kami"), was first coined.

During the middle ages there was a parallel development in the West, by Moors monks who settled in Spain after invading from North Africa. They adapted the technology for making paper from Arabs who had learned it many centuries earlier from the Japanese. Unfortunately, the tenets of the Moors' Islamic religion precluded them from creating any representations of objects found in nature, and their experiments were limited to geometric forms. The Moors were later expelled from Spain during the Spanish Inquisition, but their tradition of paper folding, called *papiroflexia*, remained. *Papiroflexia* continued to evolve in subsequent years under the Spanish and Argentines and became the basis of origami in the West.

It was not until the twentieth century that the modern origami that we enjoy today began to evolve, when a notation for recording folds was developed in the 1930's and 40's by the great Japanese master Akira Yoshizawa. Prior to this, models had been passed down through each generation by memorization, which greatly limited the complexity as well as the number of models available. With the advent of notation, not only was it possible to create models of greater complexity, but for the first time it was possible to arrive at a design without the assistance of someone who was already familiar with the model. This is particularly significant because with an accepted standard for notation, it became easy to spread new models and innovations which created an environment ripe for synergistic discovery, allowing creators to build upon the work of others.

Modern origami was popularized in the West predominantly by magicians who utilized the classic forms in their performances. One of the most prominent promoters of the art form was the English magician Robert Harbin, who released many early books on the subject, including the classic "Paper Magic" (c.1950), which was the first major origami publication to become available in the United States. Another significant early champion of the art form was Allan Cuppenheimer. The First Lady of Origami, who founded the Origami Center of America in 1958 to promote awareness and acceptance of paper folding in the United States. During the next twenty years, as origami became more widespread, many prominent pioneering folders emerged, including Fred Rohm, Neal Elias, and Patricia Crawford of America, Kunihiko Kasahara of Japan, and Liza Montoya of Argentina.

In 1979 a new wave of sophistication in paper folding was initiated when John Montroll published "Origami for the Enthusiast". Montroll felt that the stylized forms common in origami could be improved upon and went on to produce models of unprecedented detail and complexity. His work, as well as that of John Maekawa published in "Viva Origami" (c.1983), sparked a renaissance in origami design which continues to evolve today, as creators expand the window of what is considered possible. Where once there were many areas thought impossible to approach in paper folding, the complexity and scope of today's published origami forms is astounding, including animated cuckoo clocks and musicians, dragons, unicorns and other mystical beings, sea creatures, plant life and machines such as biplanes and automobiles as well as a plethora of animals with toes, wings, claws, teeth, stripes and spots. The possibilities are truly endless, limited only by the imaginations of the creators.

# Tools of the trade

## Forms of Paper

The fundamental element of paper folding is, obviously, paper, but there are huge variations in the types of media that are available to the folder. Thin papers, thick papers, soft papers, stiff papers, patterned and colored—your choice of paper can have a great deal of effect on the overall success of your model, technically and aesthetically.

The most common type of paper used in origami is “kami,” a thin, stiff paper which is colored on one side and white on the other. Kami is the traditional origami paper which can be found in most hobby shops in packs of 6” and 10” sheets. Kami is a nice medium because it takes creases well and is fairly durable through repeated creasing. Unfortunately, kami is not rigid enough to support the structures of some highly complex sculpted models. Japanese toli, which is commonly included in packs of kami, is extremely thin and rigid and is well suited for models of all levels of complexity, but it is also fragile and likely to tear after reversing a fold several times. It also shows creases very clearly, and errors made in folding are commonly rated conspicuously. American toli, on the other hand, is backed by a thicker, somewhat waxy, paper, and while it is more resistant than Japanese toli, it is not as sculptable and tends not to work as well on extremely complicated models.

Though this produces very attractive models, in general they tend to be more difficult to work with. For example, with standard paper, making a crease fractures the fibers holding it together, which weakens the paper along the fold. This makes reversing the crease easier than the initial fold, because the fibers are so weak. The opposite is true with toli, because the metal layer prefers to keep the position it is already in and thus is a better not better, it can be reversed. Also, for similar reasons, thin toli is not as easily as regular paper, which can make it more difficult to line up corners and creases while folding.

Patterned, pre-cut papers designed for folding are collectively called “chiyogami.” They come in an amazing array of sheets ranging from extremely stiff papers which crack easily to thick, softer papers which can be very difficult to work with. The patterns available are diverse and range from classic Japanese motifs to computer generated mosaics. Handmade or “wash” chiyogami is a very soft, thick paper with a consistency similar to a paper towel. Its patterns are always elegant and often utilize metallic inks. Wash chiyogami, like other handmade papers, is extremely expensive, as much as a dollar for a 6” sheet. It is also so soft that it is nearly useless in folding complicated models. But if you back it with a gum arabic toli, it becomes an extremely durable and sculptable medium which produces exquisitely elegant models.

Almost any type of paper can be used for origami. Gift wrapping paper is an excellent source of interesting motifs. Not only does it come in a huge array of patterns and colors, but because it comes in large sheets, it allows the folder to create models much larger than is possible with standard origami paper. As with chiyogami, wrapping paper tends to come in many different types of paper stock, thick, thin, stiff, soft, etc. When working with wrapping paper, consideration must be taken into the surface of the paper. Some papers are waxy or plastic coated and tend to be very slippery, some papers may not take folds well and will leave fuzzy white crease marks all over your model, and some papers tend to become smudged and dirty very easily. One must also consider the color fastness of the model, does the color come off on your fingers as you fold? As well as the photosensitivity, will the color degrade in heat or sunlight? Gift wrapping paper, which often has embossed patterns, is another excellent medium which tends to be as thin as

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- 1. This is the same reason that paper eventually tears if you fold it back and forth many times.
  - 2. Once saw chiyogami with a special pattern designed to pull eyes and a colored beak on the traditional chiyogami crane.
  - 3. When I folded a model of a black and white dragon made from unadorned, glossy wrapping paper. After a year in indirect sunlight under a heating vent, the black model had turned to a dark shade of burgundy. It was a nice color, but not as luck. It is likely that the color will continue to degrade until it achieves a muddy rose tint.



or even thinner than Japanese foil and shares its tensile qualities of being extremely flexible and soft but somewhat fragile. Other materials you might want to experiment with include paper grocery bags, corrugated cardboard, plastic sheeting, newspapers, paper towels, napkins and cloth. Anything flat and malleable is a potential source of material.

## Foil-Backing

The tensile strength and sculptability of any type of paper can be greatly improved by backing it with aluminum foil. Foil-backed papers are extremely useful when designing complex models because they can be creased back and forth almost indefinitely without tearing. Tissue foil, which is created by adhering tissue paper to both sides of a sheet of foil, is a very thin and extremely resilient medium which can be used in models of any level of complexity. I prefer generic brands aluminum foil over higher quality name brands, as they tend to be thinner and easier to manipulate. Nearly all of my show-quality models use foil-backing and have included such papers as kame wrapping paper, rice mulberry, and tissue papers as well as various kinds of handmade and hand-dyed papers. The foil is adhered to the paper with spray-on adhesive, which can be purchased in any hobby store. Choose the best quality of adhesive available, such as "Scotch Spray Mount Artist's adhesive." Less expensive brands tend not to bond as well and can separate during complex folding sequences.

To adhere the foil, place the paper face down on a table and apply the adhesive following the directions on the can. Be sure to work in a well-ventilated area as the fumes are toxic. Apply the foil to the back of the paper carefully, being wary of creating wrinkles. After the foil is attached completely, allow the surface to become sticky to the back of your fingertip to assure that a firm bond has been made. Any wrinkles in the foil do occur, rub them flat. Finally, trim the extra foil from the paper (or cut the paper into a square, if necessary) using an X-acto knife or rotary scissors.

## Wet Folding

Folding wet-moistened paper can also give a beautiful sculptured look to your models. The paper should be dampened, not from bed with a sponge or a spray bottle such as the kind that window cleaners come in. With wetting, the paper will become softer and more flexible, which makes the folding more difficult but allows the folder to mold the model into a three-dimensional sculpted form as it dries. While you and you will periodically need to rewet the model as the moisture in the paper is absorbed by your fingers. Be careful not to use too much water, or the paper could become saturated and stretch or tear. Stiffness can be added to the model by coating the paper with sizing prior to folding, which will produce a result similar to paper mache. Methylcellulose works extremely well as a sizing; it is inexpensive, will not attract insects, as will starch or flour, and can be found in most hardware stores. Methylcellulose is a very fine, nontoxic powder which is extremely hydrophilic; it has a strong affinity for water. If a tablespoon of the powder is added to a quart of water, it will produce a tub full of gooey material with a consistency similar to pond slime. Don't gross out! Scoop up a small amount in your hand and use it to coat one side of your premoistened paper, being careful to cover the entire surface evenly. When you are done, remove the excess. Proceed as you normally would in wet folding. As the model dries, it will become extremely stiff and you will be able to shape and sculpt the final result. This type of wet folding works particularly well with large sheets of handmade paper and high-quality artists' papers such as watercolor board.

1. Perhaps you should: methylcellulose is also used in some fast-food restaurants to thicken milkshakes and is the same substance that was seen in the movie *Alien III* oozing from every conceivable crack and orifice of the alien.
2. Thanks to Michael LaFosse for introducing me to methylcellulose at the national congers convention.

## Other Factors Relating to Choice of Media

When selecting a medium for a particular model, there are several things which must be taken into consideration. First, and most important, the paper must be perfectly square. If you start out with a poorly cut sheet, there is little hope of your model turning out well, particularly if it is complicated. Another important consideration is the material's strength. Is it likely to stretch or tear as you work? Will it hold up to repeated creasing back and forth, or will it split open during folding? The surface texture is also important. Is it smooth and slippery, or extremely rough? In either of these cases it will be harder to line up creases and keep them in place as you fold. The paper's rigidity will have a great effect on how well the model holds together after it is completed. Models created from softer papers tend not to hold together as well as those which are folded from stiff paper, and oil backed papers are an even better choice for models which have a molded or sculpted appearance.

When folding elaborate models and complex miniatures, the thickness of the paper becomes of paramount importance. In a perfect world, folding materials would be infinitely thin and infinitely strong, in which case any conceivable series of folds would be possible. Unfortunately, this is not the case, and if the paper is too thick, it may be impossible to execute a particular step because the model has become too bulky. To see for yourself, the effect that paper thickness has on a model, try folding a piece of kumihime paper again and again. Count how many times you can fold the paper before it becomes impossible to go any further, then repeat the test using a piece of Japanese foil. You'll be surprised by how quickly the paper becomes so thick it cannot be folded further.

## Folding Miniatures and Oversized Models

If your objective in folding is to create a work of art, it is worthwhile to consider working in miniature and/or oversized models. The overall effect on a model can be changed considerably by varying its size. Miniatures are excellent for increasing the skill and add additional challenge for the experienced folder. When you are familiar with a particular sequence, you can test your skill (and eyesight) by re-creating the model using much smaller paper. The size of the paper varies with the complexity of the model, but it is generally a good place to start. Be sure to fold on a well lit, nonreflective surface, as it makes the work easier and reduces eye strain. I prefer using a desk type lamp which casts a strong light but is not within the view of my eyes.

The most important thing to remember when folding miniatures is that errors in procedure become much more significant. For example, if you are folding a 10" square of paper diagonally and you are off by 1/2" in your aligning of the corners, it amounts to an error of only one third of one percent, but if the same error is made on a 1" square, it amounts to an error of ten times that, which is enough to cause serious problems. Fortunately, this phenomenon works both ways, and on large models there is additional room for error before it affects the project's overall structure.



1. The way to overcome this problem other than to work with extremely thin paper is to create oversized models. As the original sheet of paper grows larger, it also becomes thinner, relative to the overall size of the paper.
2. In this case, experienced means experienced with a particular model.

Another difficulty with miniatures is that when folding very small models, your fingers become huge relative to the size of the project. To overcome this problem, special tools are required. I recommend using a paper clip which has been unbent, with one end extended and the other end clamped tightly shut with a pair of pliers. This creates a versatile tool which has one end which can be used to manipulate and/or separate layers of paper, and another, rounded end, which can be used to sculpt and reverse creases without piercing the paper. Sharply pointed tweezers such as the kind available from X-acto are also very useful when manipulating fragile models which have become too small to hold in your fingers.

It is interesting to note that some models make excellent miniatures, while others lose their detail and become less attractive. For example, Montford's *thamphorynches* when folded in miniature tends to look more like a parrot than a dragon. A Simple Dragon for "Natasha" on the other hand looks excellent in miniature, but really doesn't look that attractive when folded from an average 10" sheet of paper. To a greater degree, if any models do not work well as oversized pieces. This is primarily due to the lines of the model. Models with curves or a great deal of detail tend to work better, while other models become boxy and unappealing. I have folded 4" and 6" versions of my *tarantula*. At 4" the model is extremely graceful and realistic, but at 6" it looks clumsy and awkward. On the other hand I have folded versions of the *faa'dan* dragon with wing spans as large as 24". The paper choice can also have a great deal of impact on the effectiveness of oversized models. Handmade or hand dyed papers which have attractive textures and patterns will add visual interest and make the model more compelling.

You will encounter two major difficulties when folding oversized models. The first is that large sheets of paper can be difficult to control during the folding process. This becomes less of a problem as you become more capable, once you have created the initial base, the folding becomes much easier. Luckily, since the paper's larger, errors in precision are not nearly as significant. In fact, it can be concerning how small the model might seem to be as you fold. But keep in mind that the size of the model is important and you will find that it will turn out fine in most cases. The other problem is how to obtain a large sheet of paper. The answer: construct one.

## Creating Large Sheets of Paper

There are three approaches to creating oversized sheets of paper. The simplest is to tape several squares of paper together with cellophane tape. This works well if you are extremely careful when aligning the individual sheets and orient the tape so that it will end up on the inside of the model. When selecting tape, choose a cheap, generic cellophane tape, the type that you cannot tear easily with your fingers, rather than a name brand. Generic tapes tend to be much stronger and will not tear as you work. Also, the more expensive glue is tend to be much tackier, which makes it difficult to correct mistakes if you misalign your tape, but makes it less likely that the tape will come loose as you fold.

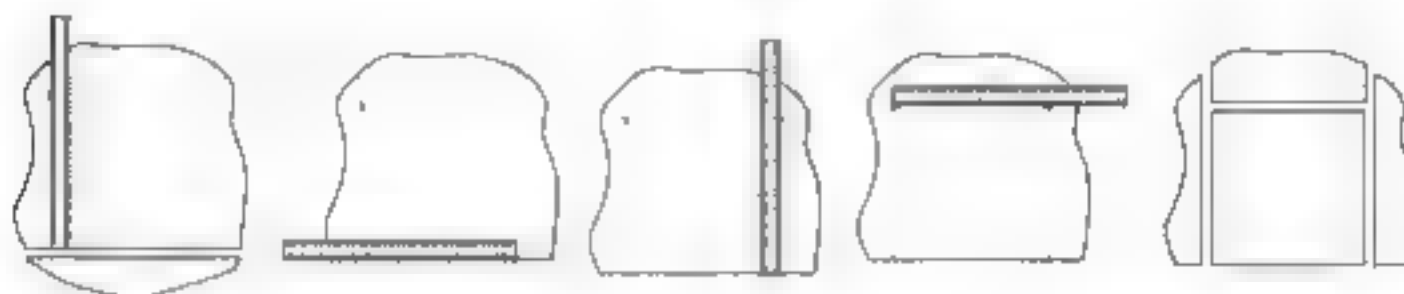
Another method of creating large squares of paper is to start with a large piece of material such as wrapping paper and trim it into a square. To cut the paper, you will need a large metal ruler and an X-acto knife. It is important to work on a totally flat, smooth surface. When cutting with an X-acto knife, hold it at a 45 degree angle and pull towards you using the ruler as a guide, applying light pressure on the knife, and heavy pressure on the ruler. It is better to make several light passes with the knife and cut through the paper gradually than to try to slice through in one sweep. Cutting this way makes it less likely that the knife will snag the paper and tear it. When using foil backed papers, place the foil side down, and use slightly more pressure on the final cuts than on the initial ones.

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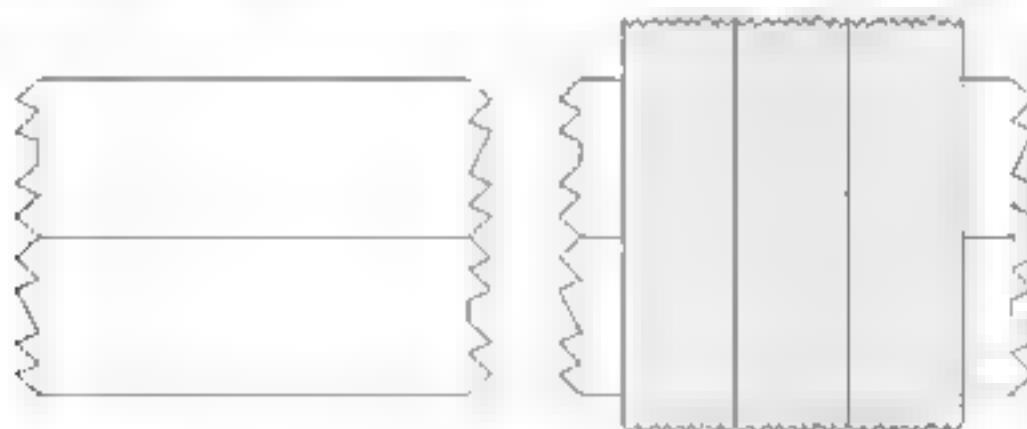
Tweezers are also useful when folding larger models. For example, to accurately align multiple pieces of paper, the tweezers will make up the strip and push the size of the paper with the tweezers at the corners where the pieces meet. Put all one strip in place by holding the tweezers in one place, then use the tweezers to hold the first strip in place while you execute the other half with your fingers.

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If the paper does not already have a straight edge on it somewhere, carefully cut one using the knife and the ruler. After the first edge is in place, carefully align the end of the ruler with the bottom edge of the paper and using a very sharp pencil, make a light mark on the paper where the first vertical crease should end. Then, mark the same distance along the bottom edge, and make another vertical mark as before. Measure the distance between the two vertical marks; it should be exactly the same as the other three, if it is not, you need to go back and find your error, otherwise, proceed with cutting the paper, starting first with the vertical cuts and then the top one.



The third way to create large squares of paper is to join large pieces of material together, and then turn the entire sheet into a square. This process can be done using cellophane tape or foil backing. To join two sheets of wrapping paper with foil backing, lay them side by side, colored side down, and cover the entire surface with foil, then press strips of tape at a time as shown and adhere them to the back of the paper. It is best to align the foil perfectly, but if you do not, it is better to allow the foil to overlap slightly rather than to leave gaps. After you have adhered the foil from the edges to make a square.



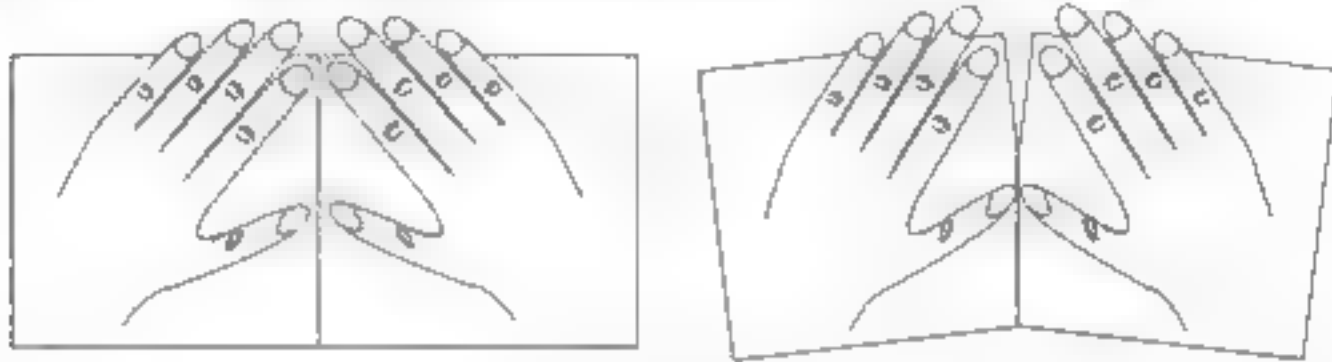
Many tools can be used for cutting other than Xacto knives. Standard sewing scissors are good for cutting accurate squares of paper, but they are difficult to use when cutting large sheets by hand. They must be guided by hand. I don't recommend using duller, less expensive scissors such as school or office scissors, because they are not sharp enough and tend to create rough, uneven edges. Paper cutters are a so-called exception to cutting squares, because they include a metal ruler which is perpendicular to the cutting edge, but they are very expensive, and must be large enough for the material. Rotary scissors, which are normally used in sewing and can be bought in most sewing supply shops, are excellent tools for trimming paper. They are extremely easy to use and cut more accurately than knives or standard sewing scissors. They are similar to a pizza cutter, except that the cutting wheel is extremely sharp and they are used with a special mat and guiding ruler.

1. When the full pencil you will use, take into consideration the difference between the thickness of the end of the pencil and the width of the razor blade when marking and cutting the paper.

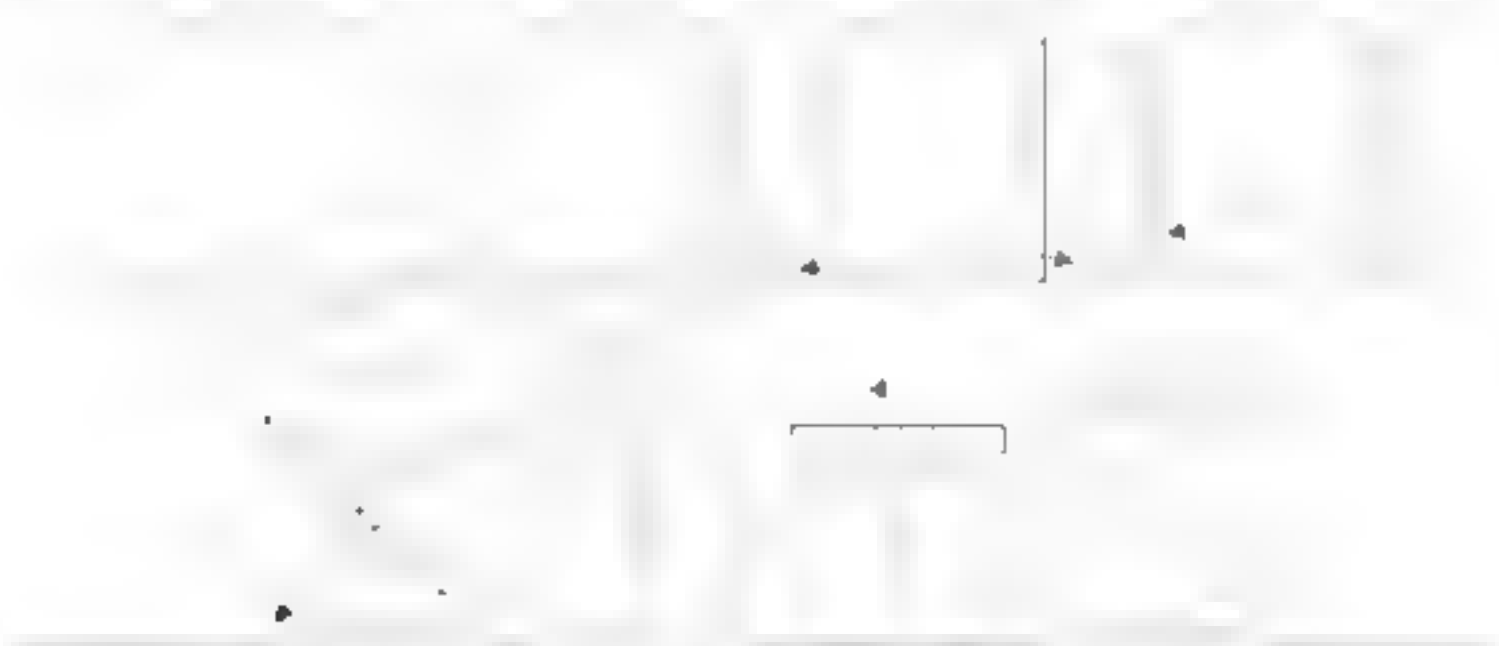
## Folding In the Wilderness

Ornament enthusiasts are compulsive paper manipulators who find it impossible to hold a piece of paper in their hands for any extended period of time without mangling it severely. It's OK—just accept it as a part of life—and learn to celebrate your compulsion, no matter where it strikes. But what are you to do if the paper you have is not square and you have no tools to work with? I've developed several defensive procedures which can be used in just such an emergency.

First, it is possible to tear paper and produce a workable edge. To do this fold the paper and crease it very sharply. Unfold the paper and fold it in the opposite direction, again creasing very sharply. Repeat this process several times and the paper will become very weak. Next, put the paper on flat surface, place your hands as shown, and gently pull the paper apart by moving your index fingers away from each other. The torque will cause the paper to split open at the top of the crease. Stop pulling after the paper has torn open approximately 2" then move your fingers to where the tear ends and repeat the process. Keep doing this until the entire crease has been split. Be careful not to try to tear too much at a time or it is likely that the paper will not tear on the crease. This procedure becomes easy with practice.



You can create a square from any arbitrary piece of paper by following these steps. If there is not already a single straight edge on the paper, make one. Fold one side of the paper lining up the edges along the bottom very carefully to assure that the vertical crease is perpendicular to the bottom edge. Do the same thing on the other side and remove both flaps using the previous creases as a guide. Next fold the paper in half and unfold, and fold and unfold diagonally. Finally, fold the upper flap downward using the end of the diagonal crease and the central crease as a guide, and unfold the flap and remove it. It is extremely important to be precise when executing this process, or else the result will not be sufficiently accurate.



Some people like to use a burnisher of some sort to do this, but I have always preferred to back up my thumbnail—works just as well and I always have it with me.

## On Cheating and the use of Cheater Bases

There are many different philosophies among creators with regard to what is acceptable when designing origami models. The most popular is "One square, no cuts." Meaning that models must be created with a single square as the starting point, and that the use of scissors is not allowed in any way. It is also felt by some that models which require foil-backed paper are inferior to those which do not, because they require an extra element in order to turn out properly. The same might be said about models which require extremely thin paper. Many also reject the use of glue or tape to attach two surfaces and prefer that the designer devise some method of fastening the flaps via folding.<sup>1</sup>

I embrace the popular "One square, no cuts" sentiment. Additionally, I feel that while a model which does not require thin paper or foil might have a more elegant design, the objective of creating is to produce a thing of beauty in form as well as design, and there will always be tradeoffs between the two. I also believe that a design in which the paper is evenly distributed over the model is superior to one which is thick and bulky in some places and insubstantial in others, and I dislike the use of rectangles, because any rectangle can be folded from a square. It then becomes the responsibility of the designer to work within the parameter that the model contains double thicknesses of paper.

On the other hand, I feel that if there is a way to "cheat" on a model which will allow you to succeed where you cannot possibly otherwise, it is acceptable to do so. The strict traditionalists are likely to find it blasphemous, but my philosophy is that it is better to have folded and taped than to have never started at all. This is particularly true in designing. Conceivably, it might be possible for me to create a model that is so difficult that I cannot fold it. Does this mean that it can't be folded? No, it is likely that someone who is a more proficient folder could. Am I to not design a model if it means that I have to use tape to help me along?

One of my models where "cheating" is used is Robert Lang's Sea Creature. It includes many steps which require the unfolding of a double layer of paper, which is extremely difficult with any method, particularly those which are foil-backed. To simplify the process, a needle can be inserted near the ends of each fold, and the point can be used inside the model to separate the layers of paper. Clearly, this is cheating, and it makes the model somewhat making it less desirable than one in which there are no holes, but will you doing so, the folder might not be able to complete the model at all. Is it valid to do this? Yes, so long as there is some conceptual method of executing the model without doing so. Often, cheating turns out to be a good planning tool which allows the artist to fold the model on his or her own as a learning tool.

Thus, the inclusion of cheater bases in this book. Several of my models, including the tarantula and "Frog Dragon" were designed using cheaters. I find that utilizing them makes sense as it simplifies the design process by eliminating the extra layers of paper which are internal to the folded bases. In the case of the "Frog Dragon" it also saved a lot of time; it's much faster to create an eight-sided cheater base than to make a carefully constructed folded base, and I went through a lot of eight sided bases. In these cases, the end justifies the means. Ultimately, one could say that a better overall design might have occurred were the folded base being utilized, and that's probably true, but the design process is challenging enough as it is. It makes sense to use whatever tools are available.

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<sup>1</sup> In origami circles, one can often hear rational references to these unmovable tools by their first letter only. "Does anybody have the 's' word?" "Does anybody have the 'f' word?"

## Notation

The figures in this book utilize a common set of symbols which is based on the globally accepted notation created by Akira Yoshizawa. Some additional symbols have been added.

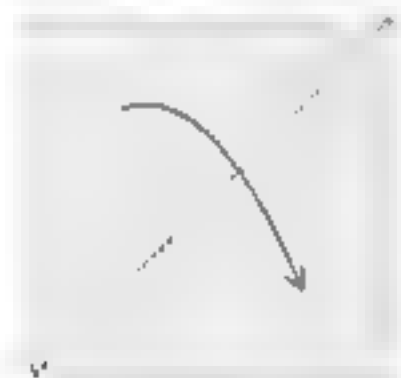


Most models in this book are assumed to be folded from a single original piece of paper. If it is not the side and white regions of the model illustrations in this book, the colored regions of the paper are represented by shaded regions and the white portions of the paper are represented by white regions.

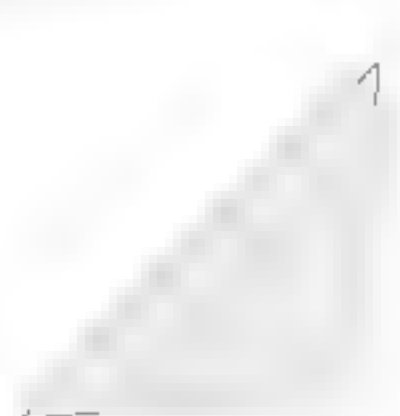
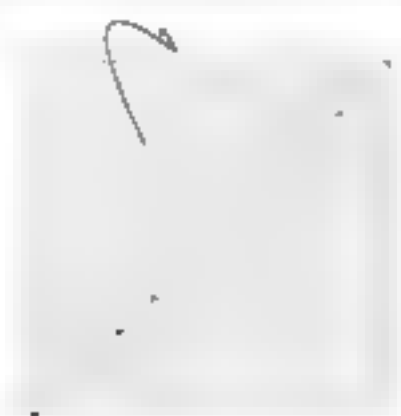
The edges of the paper are represented by solid lines that meet at the corners. An edge that is part of the original paper is called a raw edge. An edge that is not part of the original paper is called a folded edge.

Creases that have been made out do not form an edge and are represented by lines with a small square at the end to represent the original corner. If some cases where very complicated creasing is being done, the lines are extended all the way to the edge of the paper to make the overall crease pattern clearer.

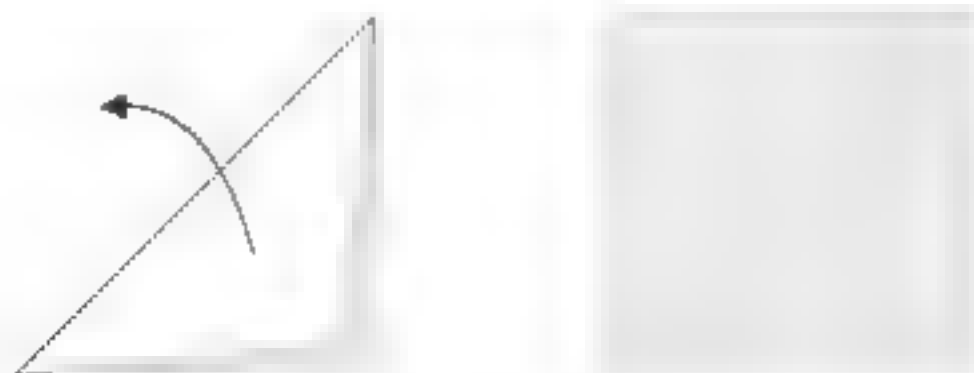
**Valleys and Mountains** A piece of paper can be folded in one of two directions: toward you and away from you. When a piece of paper is to be folded toward you it is represented by a dashed line. This type of fold is called a valley fold because it forms a trough or valley in the paper. Valley folds are usually accompanied by open-headed arrows which indicate the direction in which the paper is to move.



When a piece of paper is to be folded away from you it is represented by a line composed of alternating dashes and dots. This type of fold is called a mountain fold because it forms a ridge or mountain in the paper. Mountain folds are often accompanied by arrows with half a closed head which indicates that you are to fold the paper behind. An easy way to remember which line represents the valley fold and which line represents the mountain fold is to keep in mind that valley folds are simpler to execute and are represented by a simpler line. Mountain folds are more complicated and are represented by a more complicated line. To simplify mountain folds, the folder can execute them backwards by turning the paper over, executing a valley fold instead, and then turning the paper over again.



**Unfold** When the paper is to be unfolded, it is indicated by a solid, closed-headed arrow



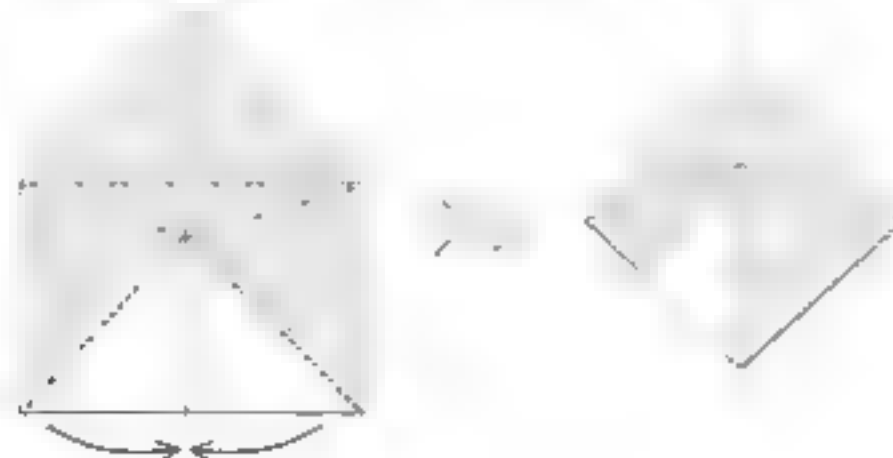
**Fold and Unfold** When the paper is to be folded and unfolded so that a crease is made, it is shown by either an arrow that doubles back on itself or a two-headed arrow combining both the standard directional arrow and the unfold arrow. In some cases the direction of the creasing is important, so watch the direction of the arrow. In both the illustrations below, the paper should be creased by first bringing the upper left-hand corner to the lower right, and unfolding.



**Grow and Shrink** Often, as the model becomes more complicated, it becomes necessary to enlarge or reduce the figure. Enlarging is shown by an arrow with a small tail and a large head, and reduction is shown by an arrow with a large tail and a small head.

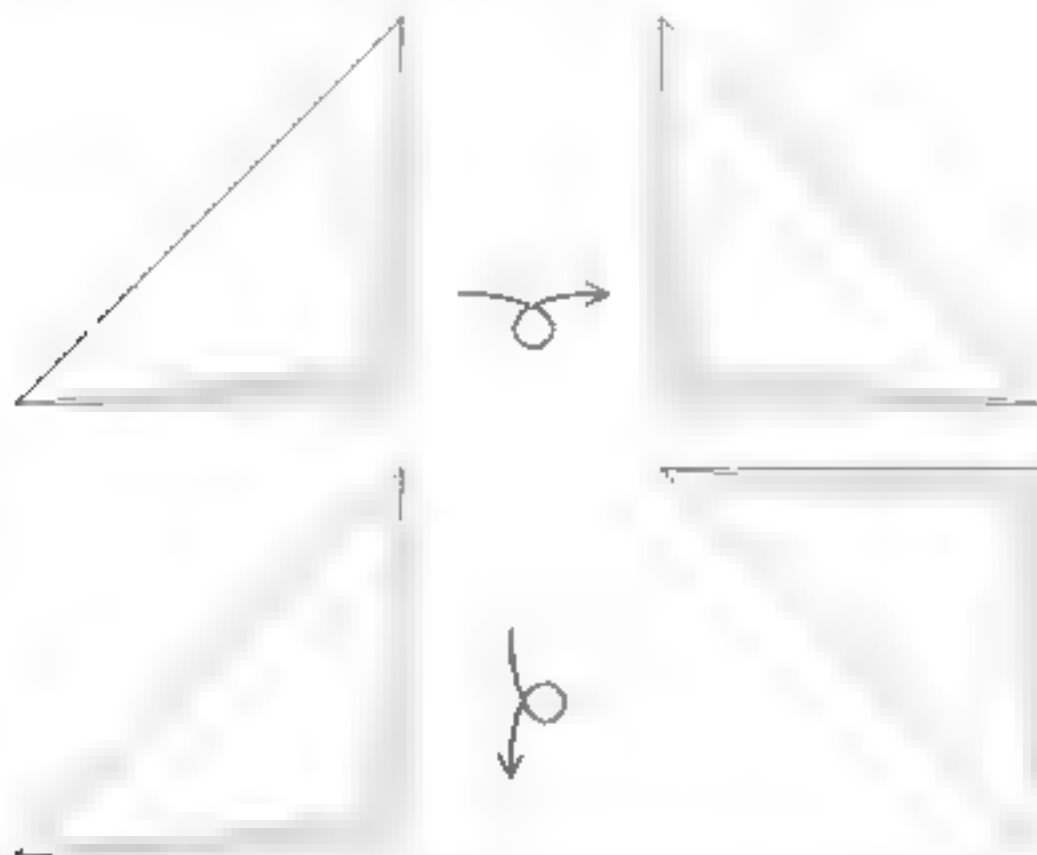


**Next Step this Way** In some cases, particularly when steps are not numbered, an arrow with a proportional head and tail is used to indicate the direction of the next step.

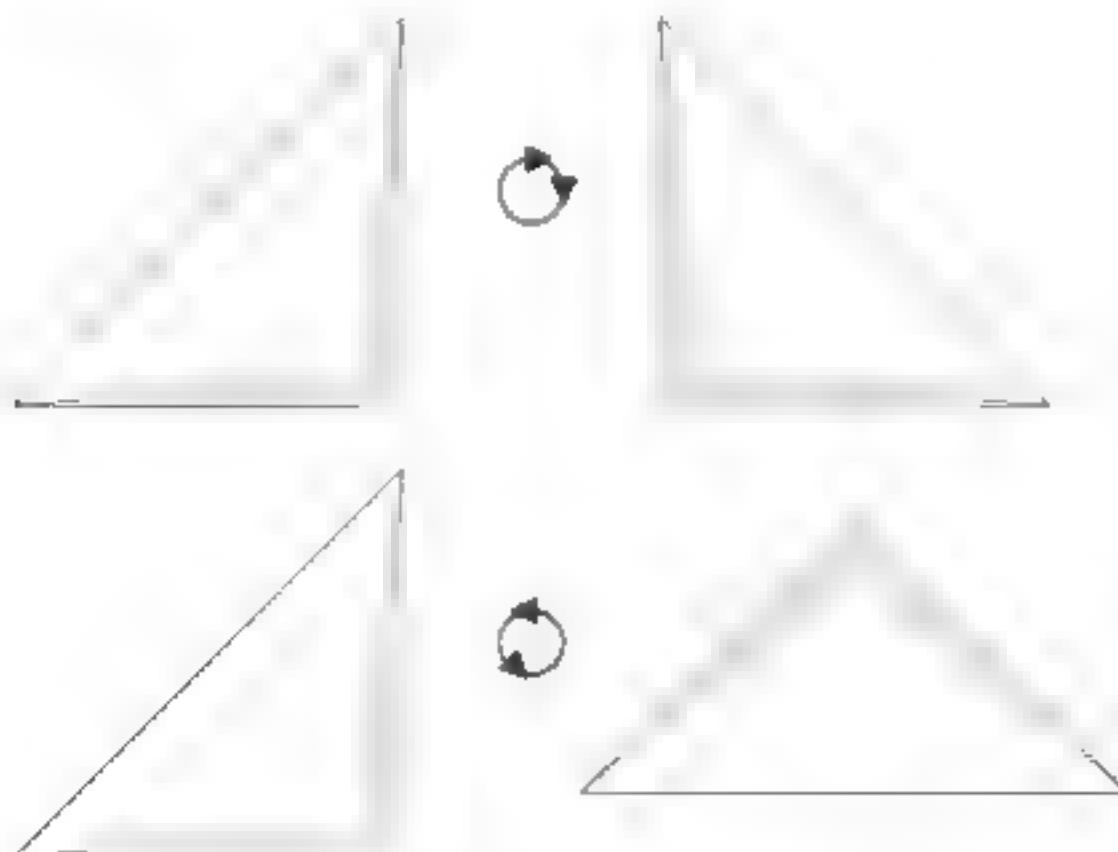




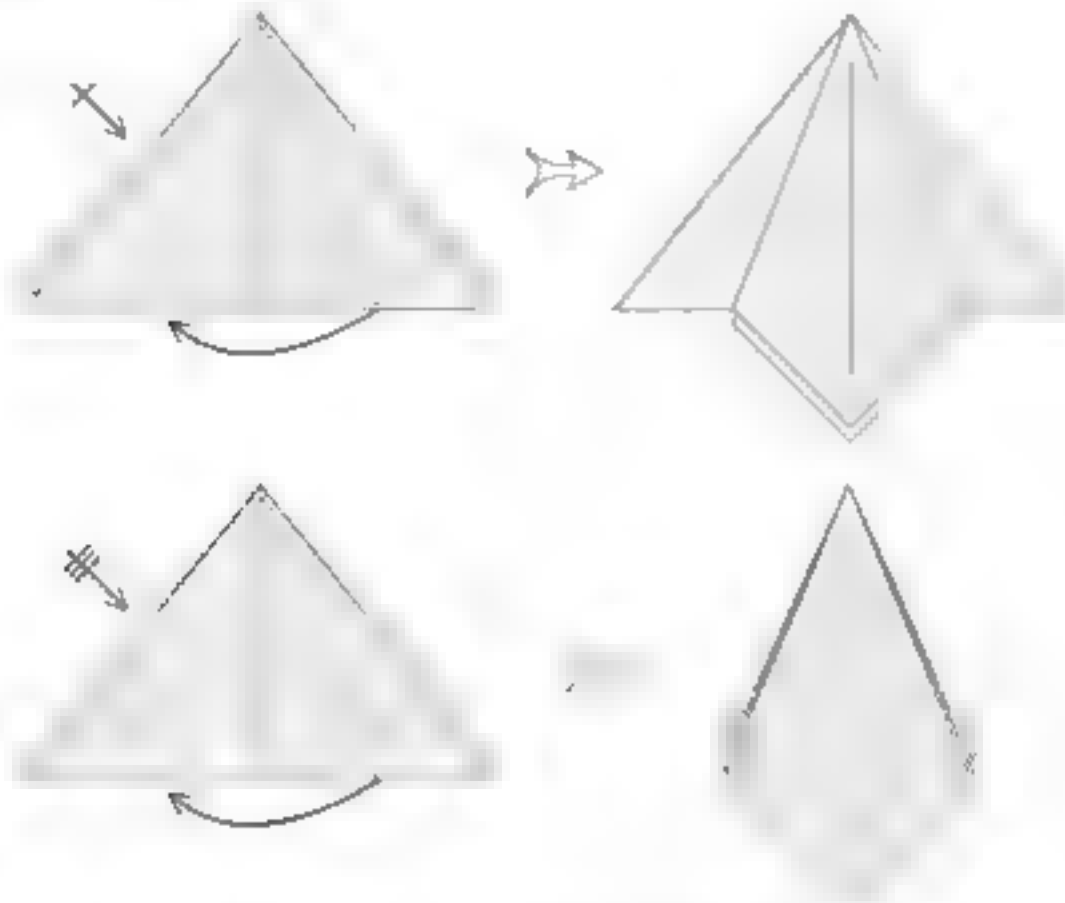
**Turn the Paper Over** When the paper is to be turned over a looping arrow is used. The paper should be turned over in the direction of the arrow, either left to right or top to bottom.



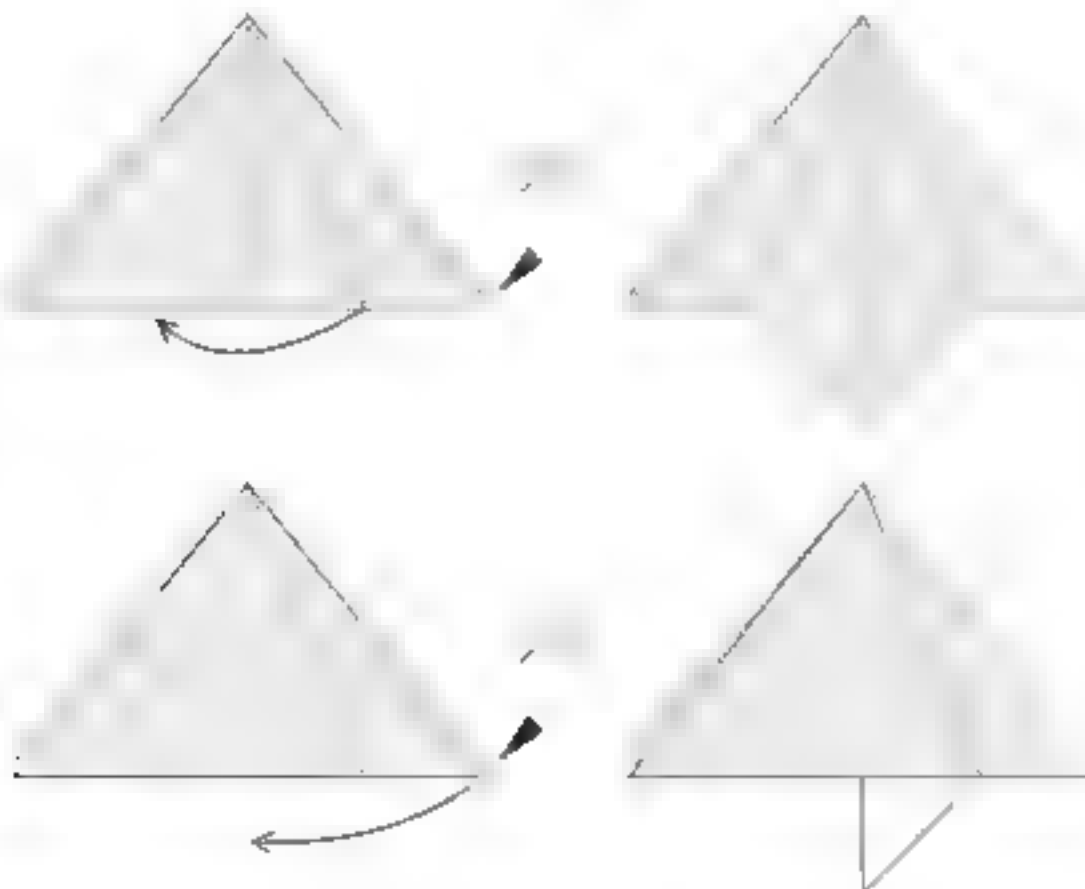
**Rotate** A triangle with two arrows on it indicates that the model is to be rotated a certain amount in the direction of the arrow. In the first example, the symbol indicates that the model is to be rotated 90 degrees to the right. In the second example the symbol indicates that the model is to be rotated 135 degrees to the left.



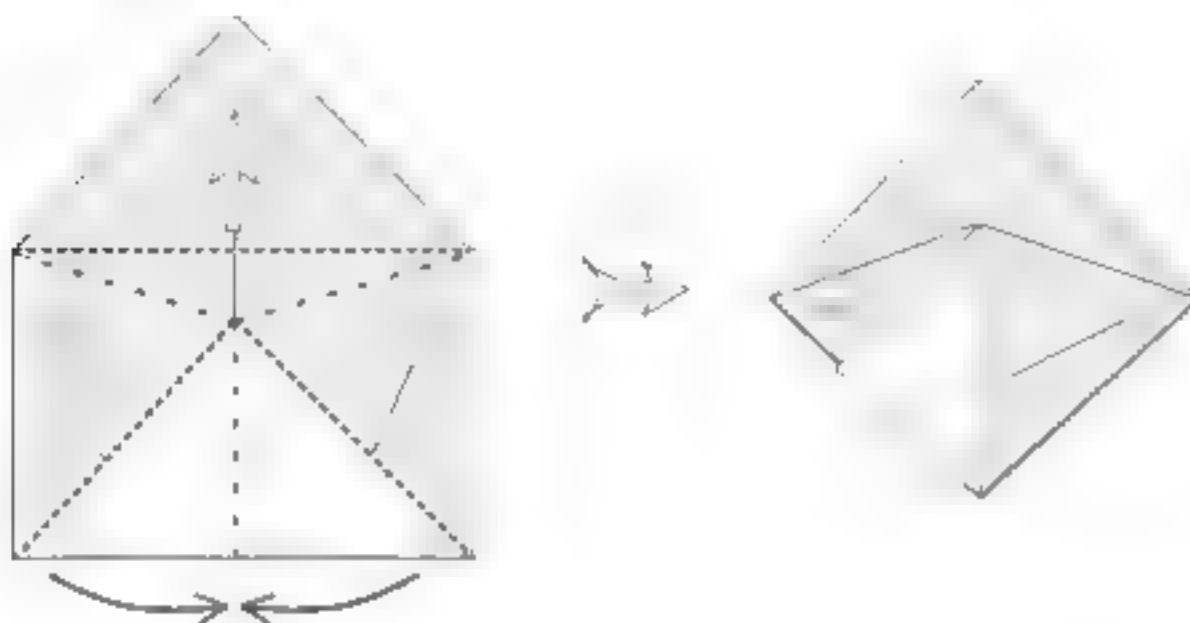
**Repeat Behind** Often, when a step is to be repeated several times, a crossed arrow is used. The number of lines crossing the arrow represents the number of times the step is to be repeated. In the first example below, the squash is repeated one time on the other side. In the second example, the squash is repeated three additional times.



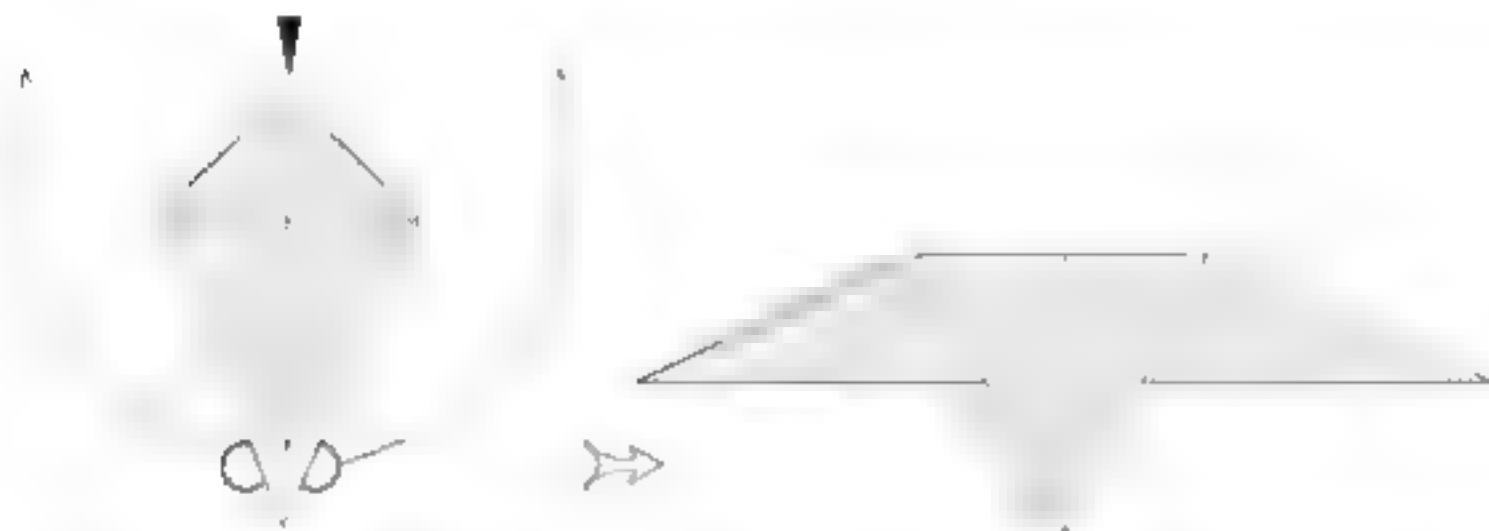
**Push Paper in this Direction** When the paper is to be folded so that push reverses, a crossed arrow with no line is used. The three main cases where this symbol is used are in squash folds, over-squashes and sink folds.



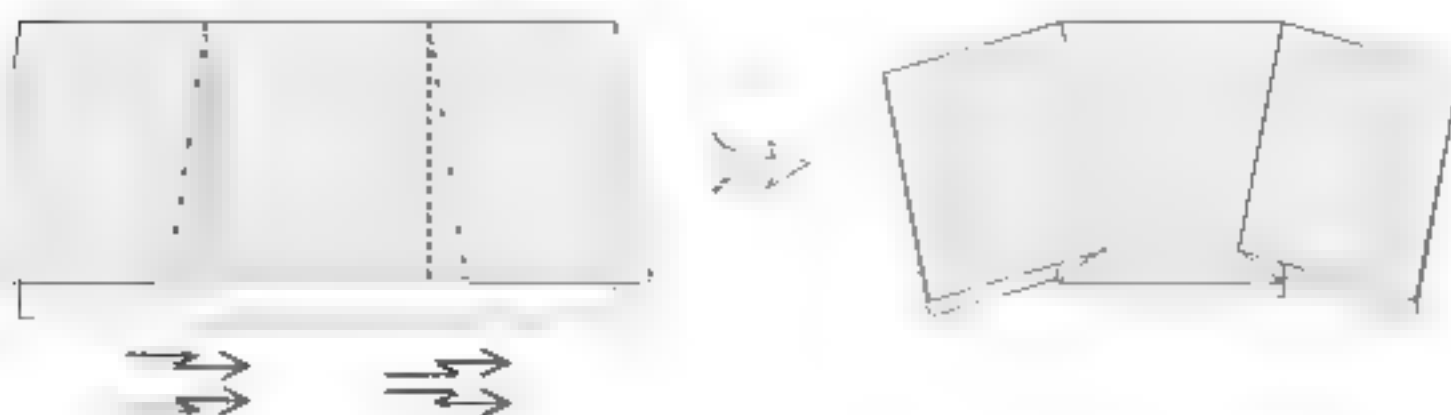
**Paper Moves in this Direction** In some complicated folds it is helpful to show that part of the model is being moved in a particular direction. This is shown by an outline or an arrow indicating the direction of the movement.



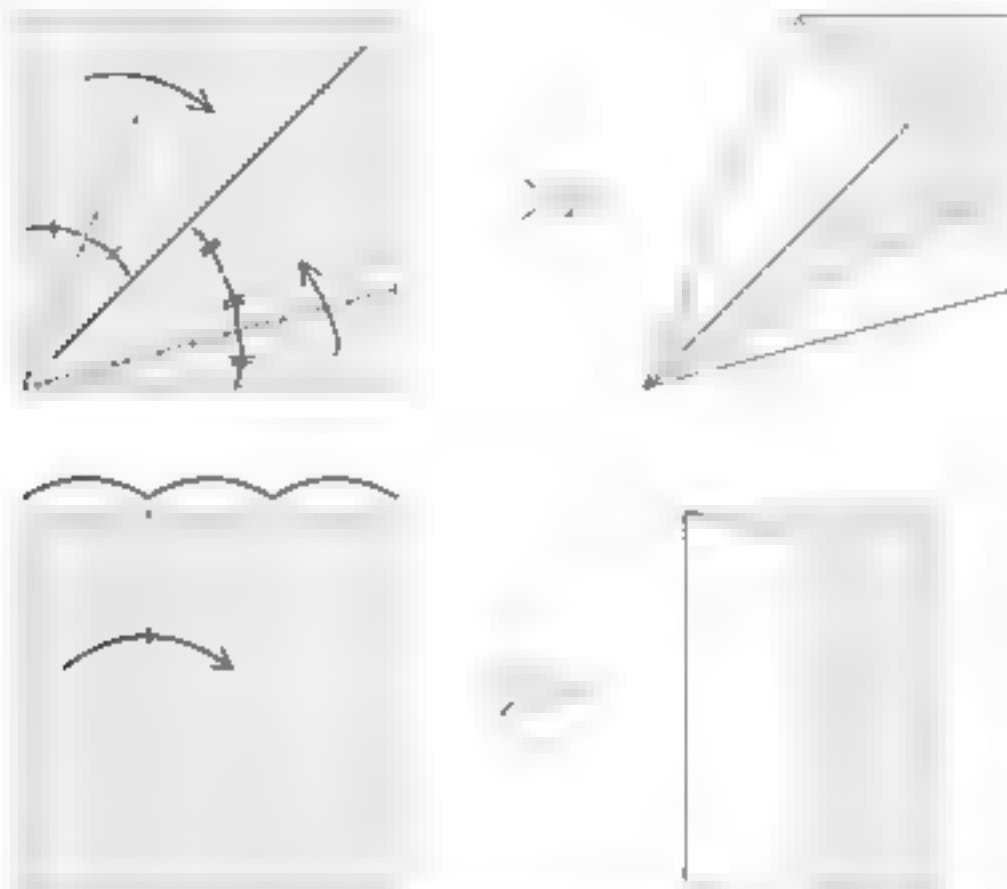
**Pinch Here** When the model must be held in a certain way or place, the placement of your fingers is shown by a circle. Often the circle is obscured to indicate that your fingers are to be placed under layers of paper.



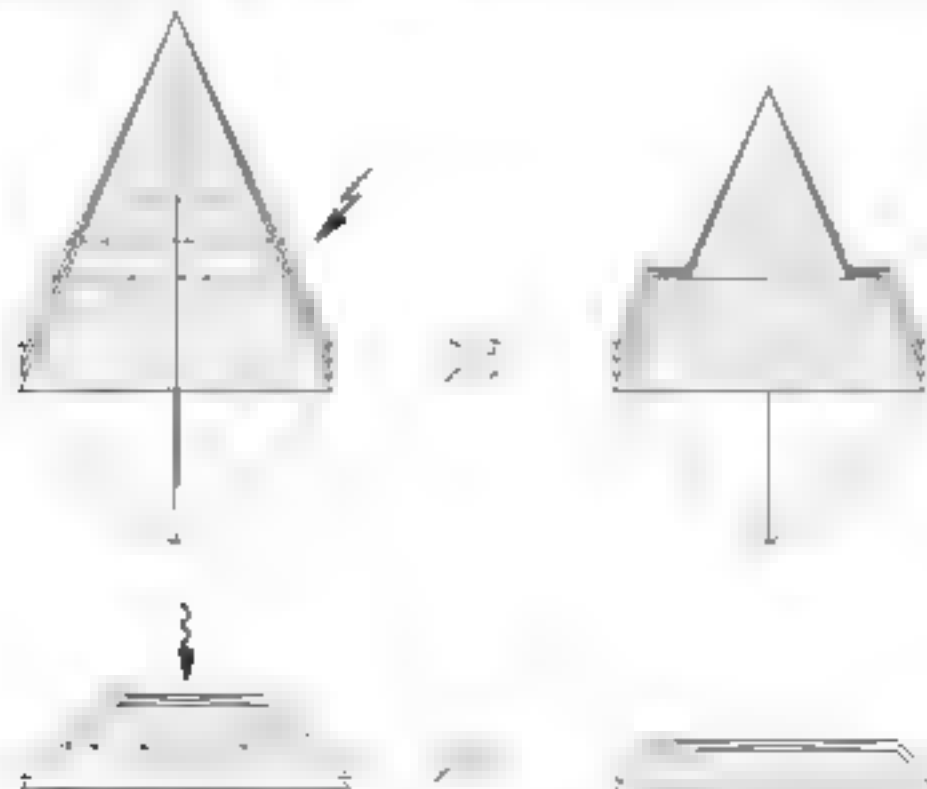
**Crimp** Crimps are folds where the paper is folded in such a way that the paper is crimped inside itself. There are two ways to position the folded layers, inside and outside. The arrows are used to indicate the desired configuration. The direction of the arrows has little effect on how the fold is executed.



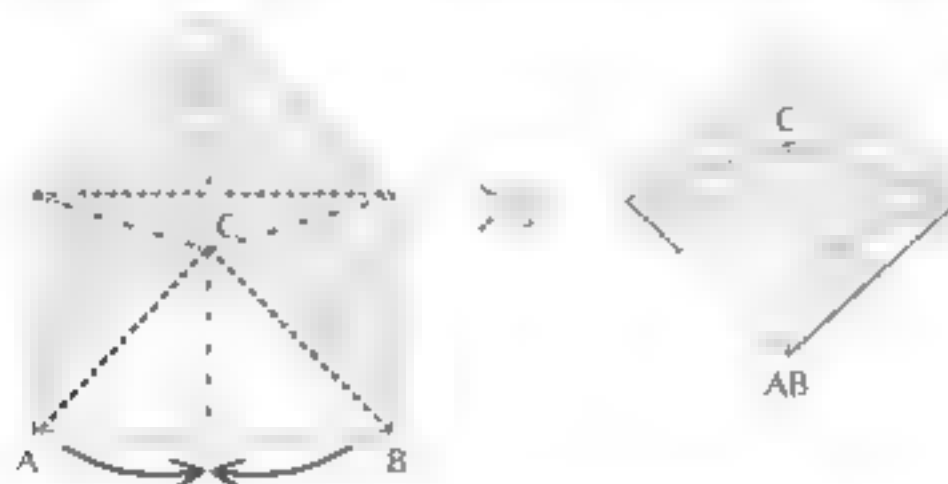
**Equal Distances/Equal Angles** When the paper is to be folded in proportional distances, braces are used to indicate the ratios. In the example below, the paper is to be folded at a ratio of 1/3 to 2/3. When the paper is to be creased in proportional distances along an angle, a brace with a cross is used. In multiple proportions are being illustrated on the same figure, multiple crosses are used. In the example below, the left side of the paper is to be creased at a ratio of 1/2 and the right side is to be creased at a ratio of 1/3 to 2/3.



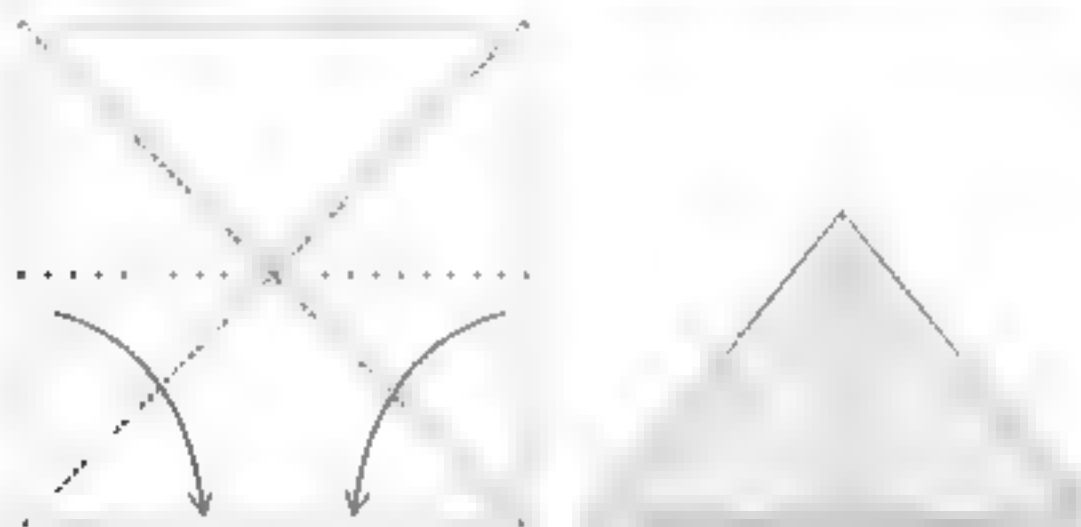
**Special Sinks** There are two special types of sinks used in this book: pleat sinks and crimp sinks. Pleat sinks are a form type of sink where a flap is unfolded and then pleated back into place. Crimp sinks are multiple-level sinks which are executed simultaneously in the same area. The pleat sink is represented by the "Push Flap in this Direction" symbol with a crooked tail. The crimp sink is represented by the "Push Flap in this Direction" symbol with the tail of the crimp symbol. More information about these techniques can be found in the next section.



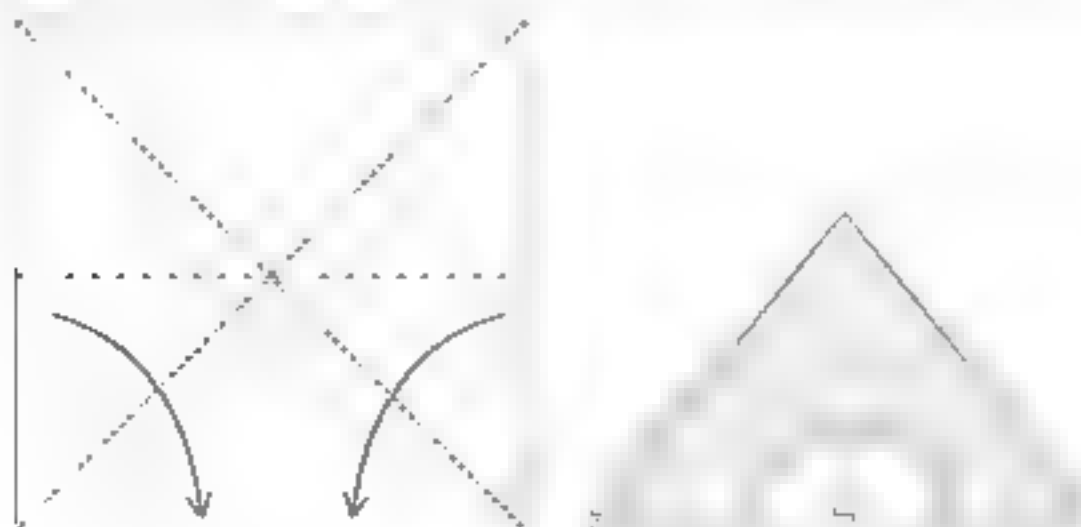
**Watch this Point** In some complicated folds, where it is easy to become disoriented, it is helpful to show where certain points on the model will be after the fold. Capital letters are used to show this. In the example below, points A and B are being moved towards each other and point C will move upward.



**X Ray View** X ray views are used to show important structures of folds which are hidden inside. The model parts are represented by a dotted line. Dotted lines are also used to show where a portion of the model will be after you have completed a step. In cases where dotted lines are used, the text will explain precisely what they represent.



**Cut Away View/Partial View** These views show the model as it would appear with a hole cut out of it, or a with a portion missing. Cut away views are used when the internal structures of the model must be shown in detail. The edges of the hole are represented by a thick gray line. Partial views are used when only a portion of the model is being shown. When partial views are being used, the paper will usually be missing an edge, or in some cases, they will have the same thick gray line used in cut away views.



## Techniques

There is a great deal of variation in the difficulty of origami models, and so far as I know, no accepted standard for assessing the complexity of a particular model. It is extremely useful to grade models by difficulty because it gives the folder a sense of what they are getting into. As an attempt to address this issue, I have created a scale which I use throughout this book. It is based on a combination of the grading method used by the Friends of the Origami Center of America (Origami USA) and the one used by John Montroll in his later books.

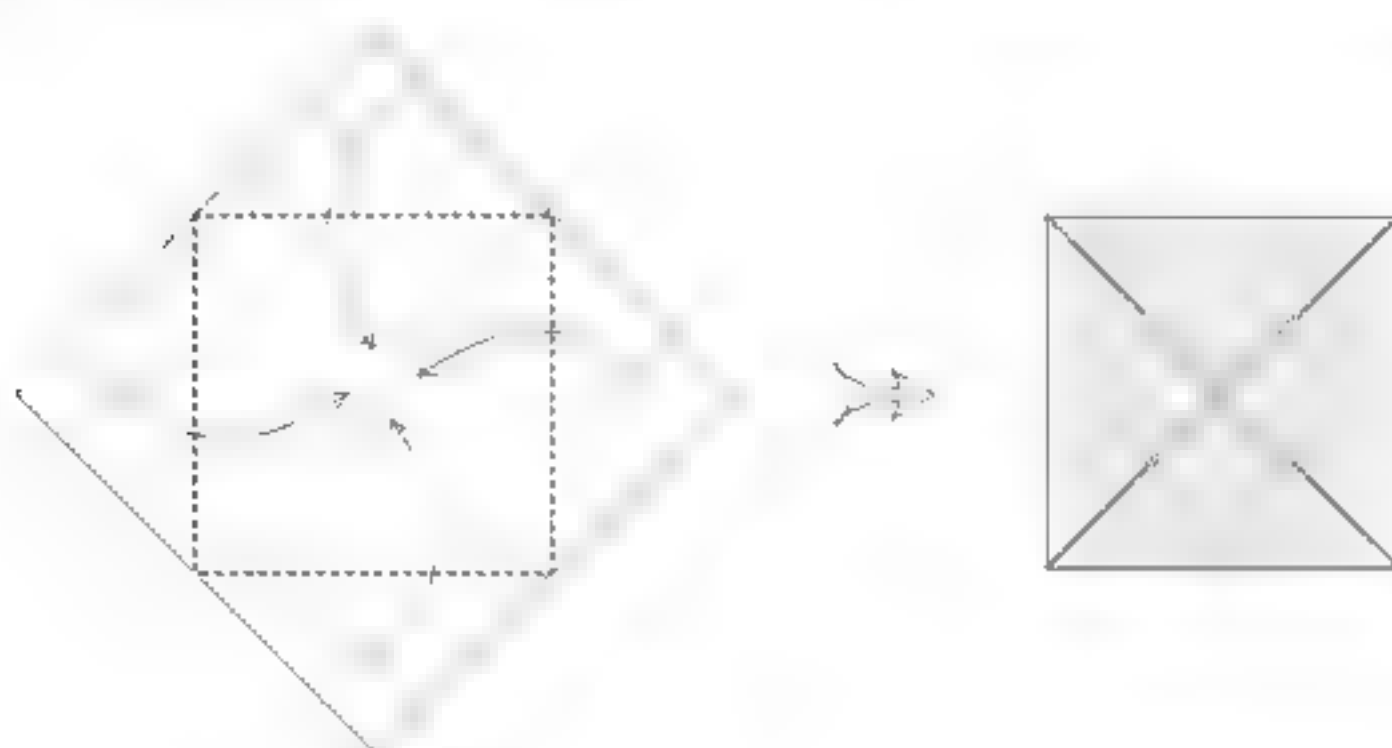
The scale is delineated by the various techniques that can be used when folding models. The more difficult the technique, the higher the difficulty rating of the model. While the scale is specific in its definition, it is somewhat open to interpretation. For example, if a model is composed primarily of techniques from level I but also includes one simple example of a technique that is rated for the next level, the model would most likely be rated a II, because its overall difficulty is a level II. But if several techniques from the next higher level were used, the model would be rated higher.

The scale is broken down into three primary levels of difficulty: Beginner, Intermediate, and Complex. Each of these levels can also be designated as advanced or not, for a total of six levels. These levels are defined as follows:

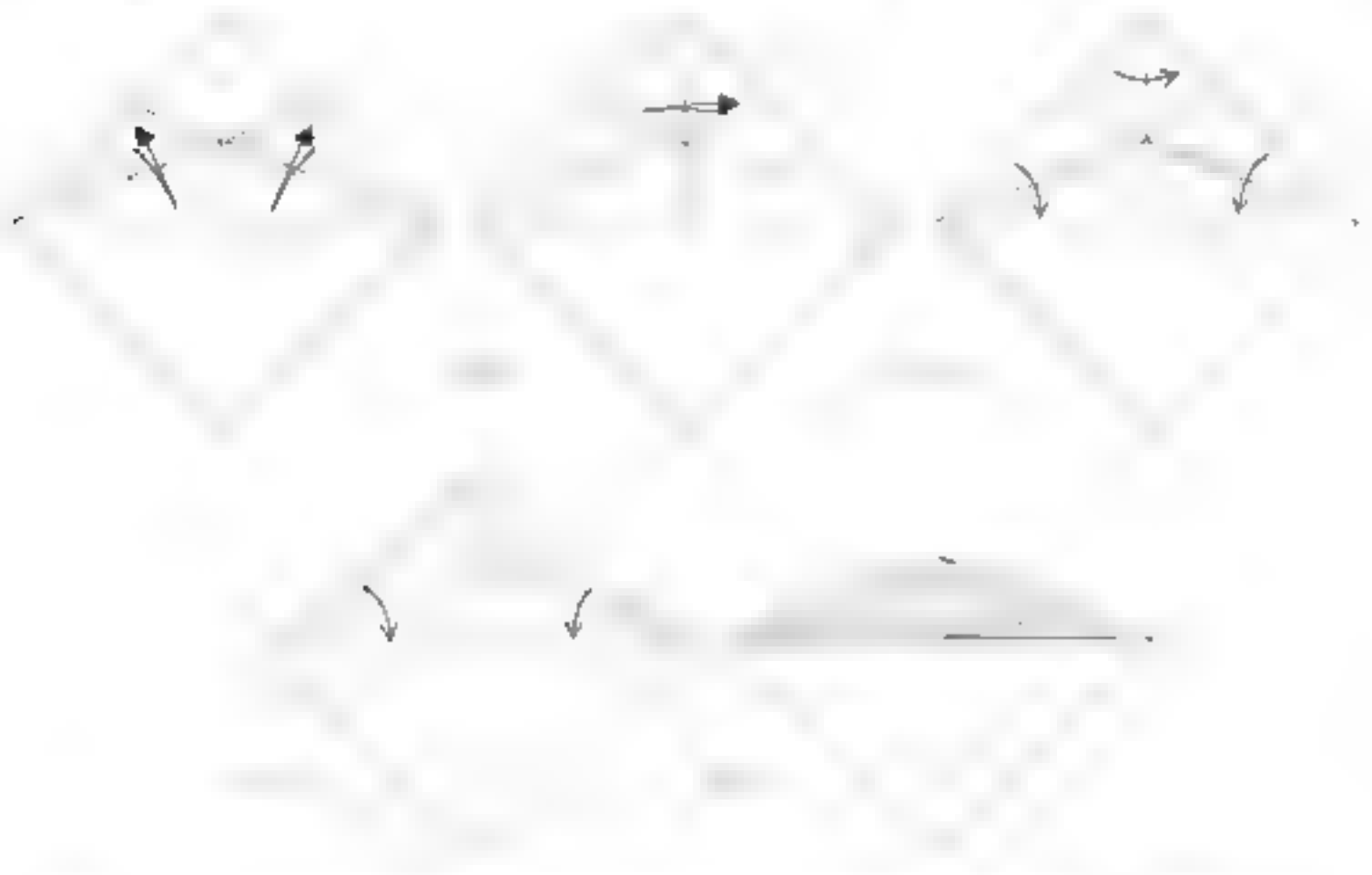
### Level I - Beginner

Models at this level are of the simplest level of difficulty and can generally be executed by anyone of any age or experience level. The techniques allowed are limited primarily to folding paper forward or backward. Models of this type, which are composed of only straight-forward creasing, are called "Pleat" and "O-gami." Designing models in the pleat-and-fold mode is more difficult than one might expect. It is extremely challenging to create an interesting model with just a few simple creases. Imagine trying to create an interesting piece of music with only 3 different notes, such as "Mary Had a Little Lamb." In addition to the simple creases of the pleat-and-fold mode, level I also includes the rabbit ear, which is a very simple and fundamental construction, and the wave fold. Level I is analogous to models graded "Simple" on the Origami USA scale and to "\*" on John Montroll's scale.

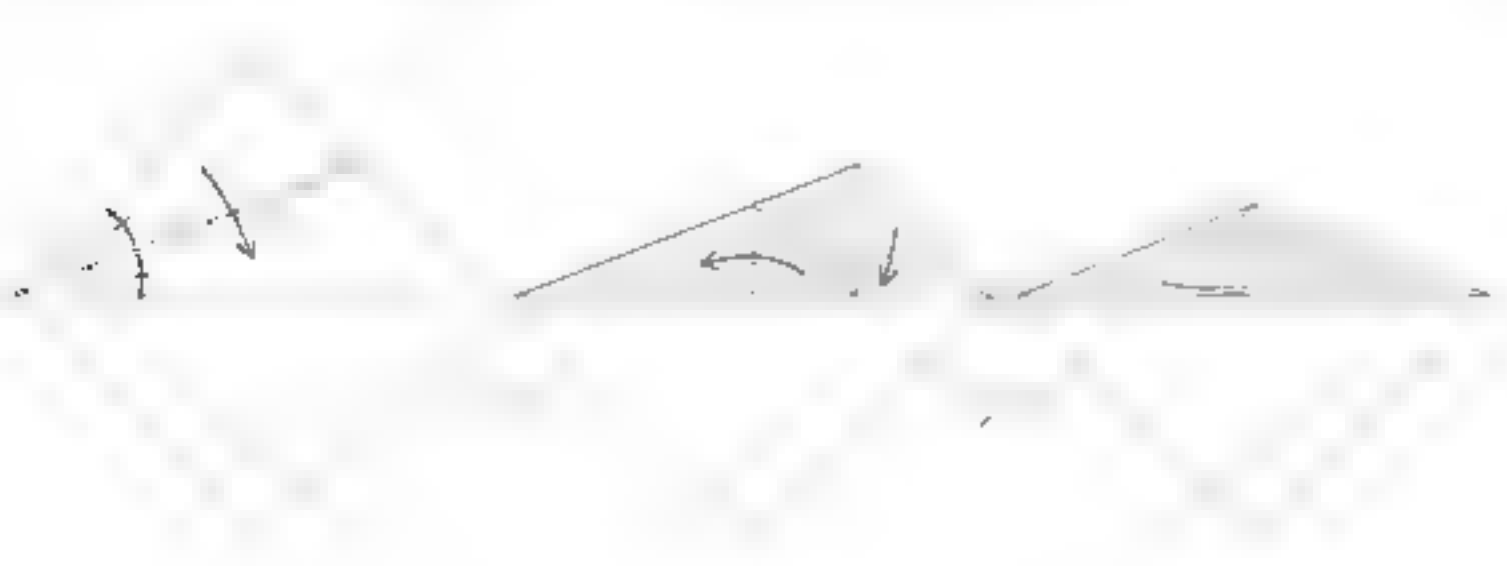
**Blintz Fold** The blintz fold is common in simple models. In origami, blintzing means to fold all four corners to the center.



**Rabbit Ear** Rabbit ears are used frequently in origami. Rabbit ears take many forms from the classic example described below to the one used in the ears of Patricia Crawford's Kangaroo. One of the common aspects of rabbit ear folds is that the paper is being pinched together and compressed in some way or another to create a thinner point. To fold a rabbit ear first crease the paper in both directions along the diagonal then crease the vertical line in the center. Next following the creases bring both the upper edges of the paper downward. As you do this a new point will appear. Place it on the right side and flatten the model completely creating the extra mountain fold shown in the third figure.



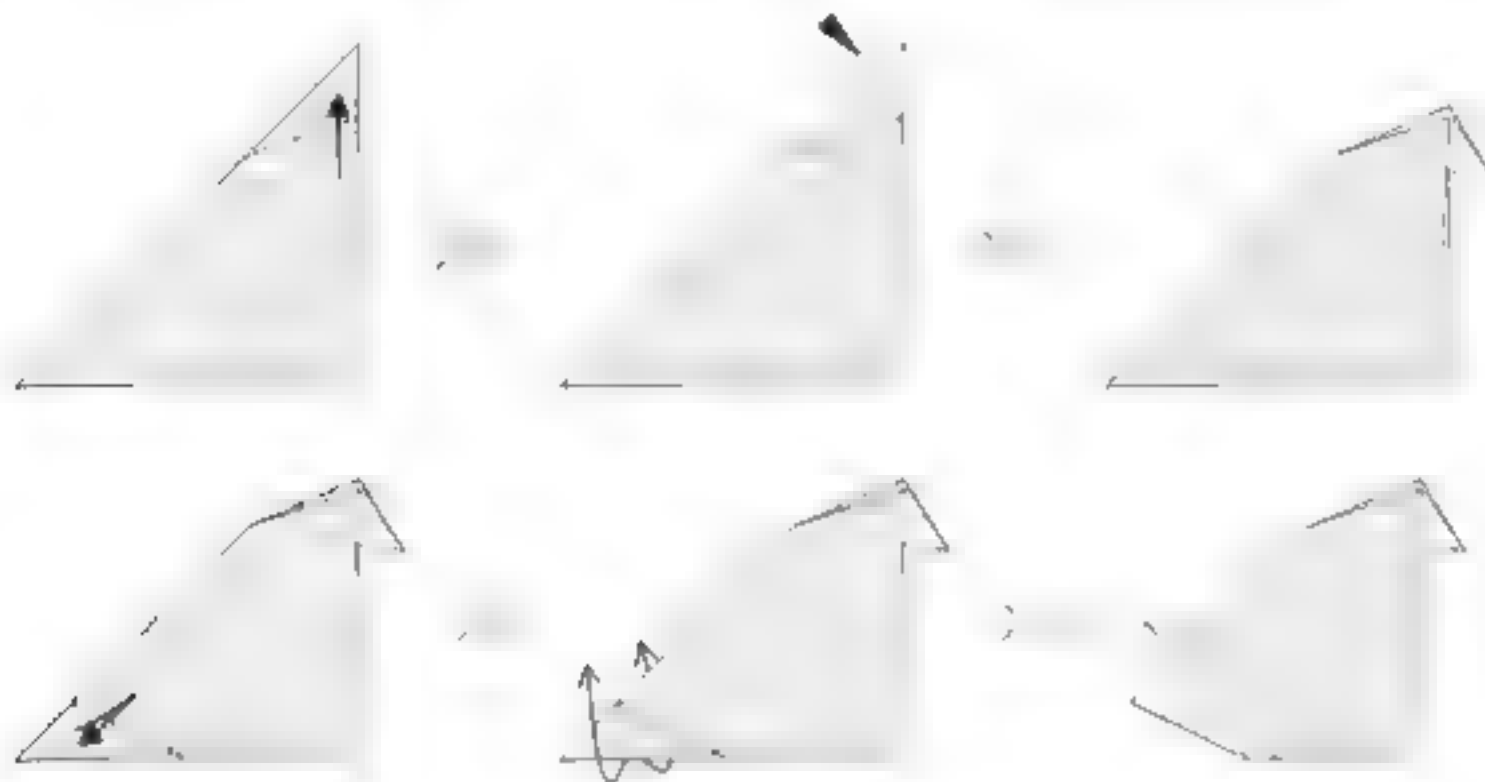
**Swivel Fold** Swivel folds are extremely common and also occur in many forms. A swivel fold occurs when a flap or point is pulled in one direction and the action passes another flap in a different direction. The example below shows how to fold the rabbit ear executed previously using a swivel fold. First precrease the paper as you did before but this time leave the leftmost flap in place. Next pull the corner of the colored flap to the left. Doing this will cause the flap on the right side to go downward at the already existing crease. This is the swiveling action to which the name refers.



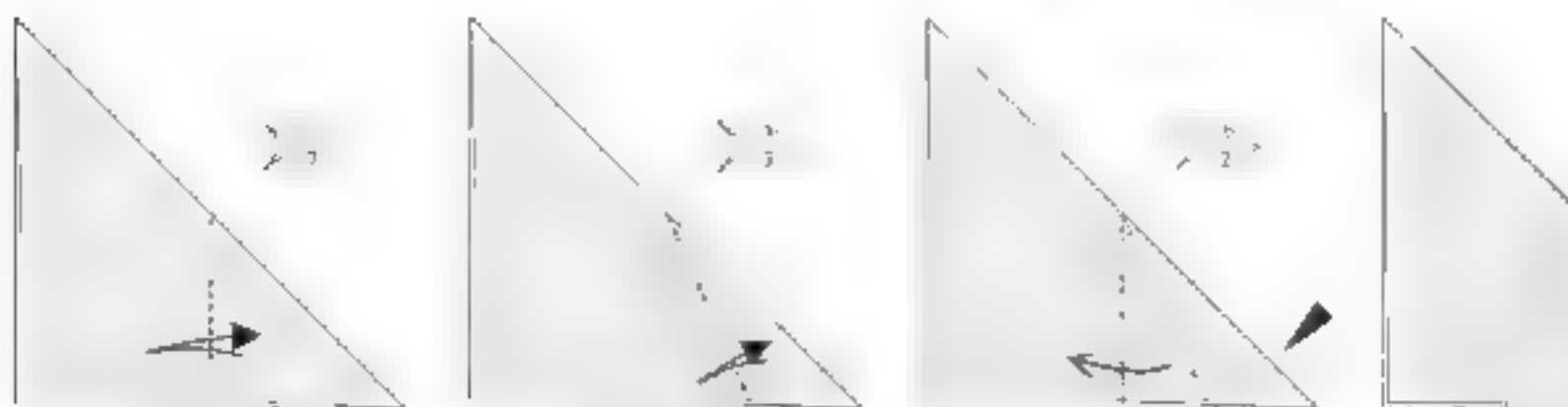
## Level 1+ - Advanced Beginner

Models at this level are still quite simple, but they include some techniques which are difficult enough that they might stump some novice folders. The techniques are not difficult, but some like the petal fold, might be confusing until the procedure is demonstrated to them by a more experienced folder. Level 1+ is analogous to "low intermediate" on the Origami USA scale and also rates a "7" on John Montroll's scale.

**Inside/Outside Reverse Folds** Reverse folds are used to reverse the direction of a point. They can either be positioned inside wherein a point is pushed in between two layers of paper, or they can be positioned outside wherein a point is wrapped around two layers of paper. Inside reverse folds are illustrated in the first three figures and outside reverse folds are illustrated in the second three figures. Reverse folds are easy to recognize: inside reverse folds are indicated by the solid triangle symbol and outside reverse folds will always be indicated by two arrows.

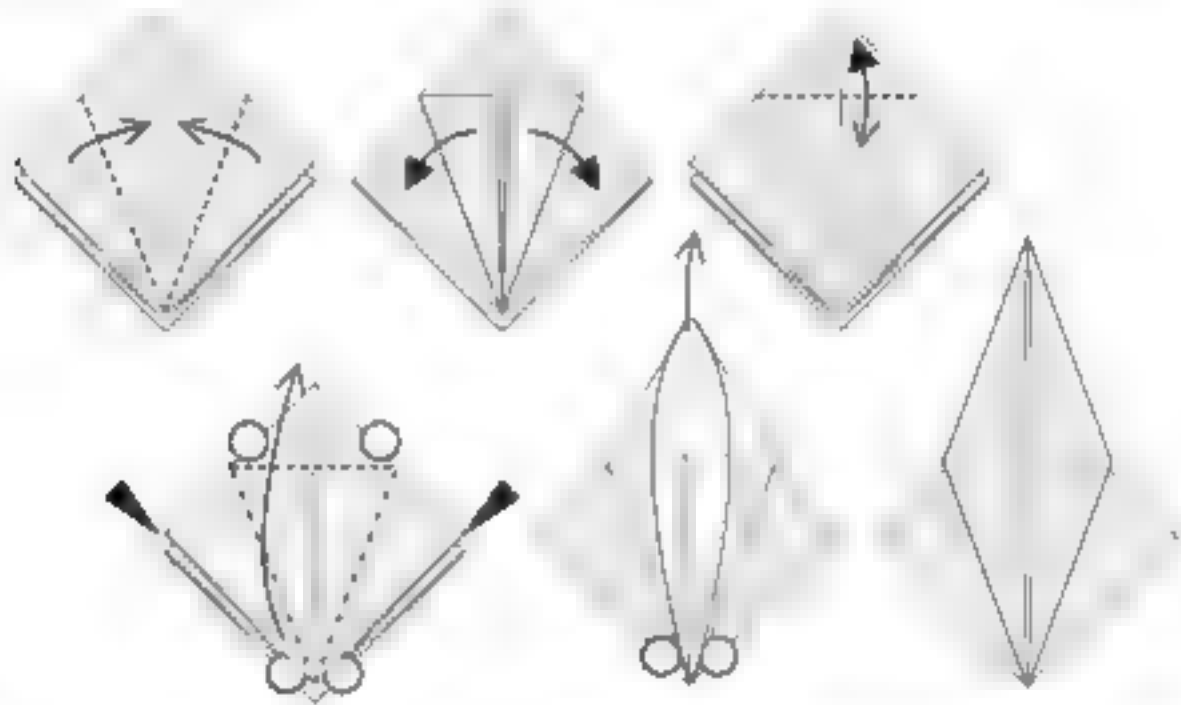


**Squash Folds** Squash folds are used to flatten a point and create a new region of paper. Squash folds are also indicated by a solid triangle. To execute a squash fold you should first precrease along the two vectors that will form the fold, and then, using the creases as a guide, squash the point downward, causing it to flatten out.

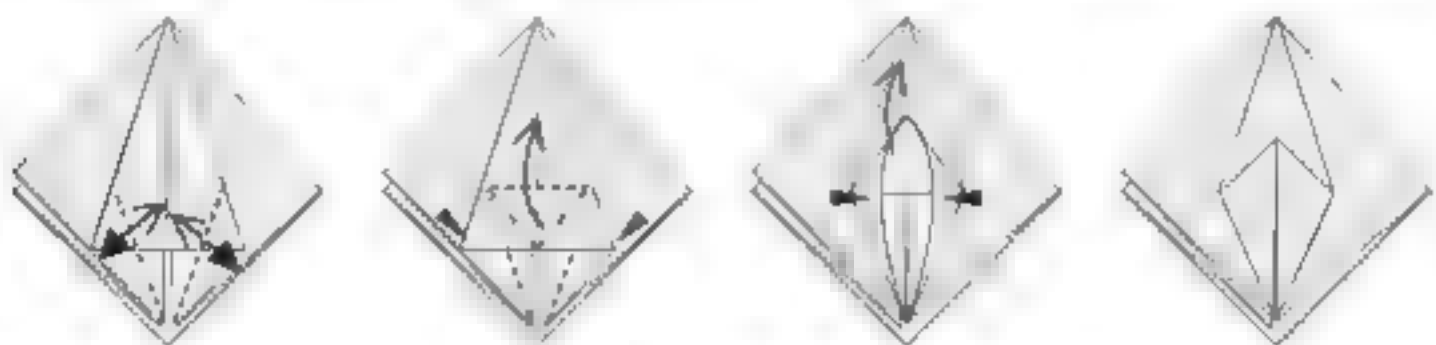




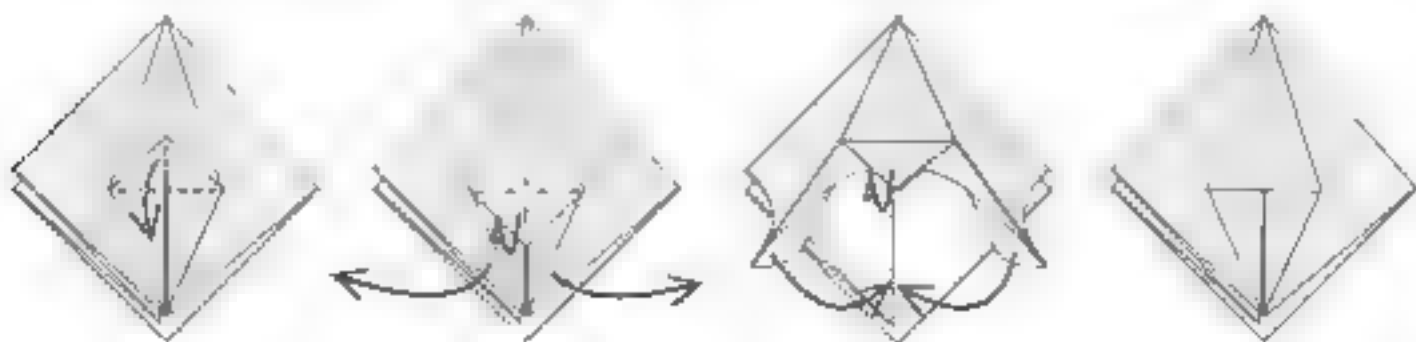
**Petal Fold** A petal fold is a special technique which is used to taper and lengthen a point or to create a new point. It actually consists of two simultaneously executed swivel folds. The petal fold is often confusing to the novice folder the first time it is encountered, but once the proper technique is learned, becomes simple. Petal folds occur in many forms. One of the most common is executed on the point or a flap, starting with a preliminary base. First precrease the left and right diagonals by folding the edges inward and back out. Then crease the top edge by folding it downward and back up. To execute the petal fold, place your fingers at the top of the model just above the horizontal crease and grab a single layer of paper at the bottom. Pull the lower point upward while keeping the paper above the horizontal crease pressed flat. As you do this the sides of the paper will pull inward. Keep pulling the flap upward and finish the fold by flattening it out completely.



Petal folds can also be executed on the edge of a flap. Start with a preliminary base where one flap has been squared to meet, as in the frog base. The left and right diagonals should be creased as before, but there may be a simpler way to precrease the horizontal line. To execute the petal fold use the same procedure used previously: place your fingers above the horizontal crease, grab a single layer of paper at the bottom and pull it upward, causing the edges of the paper to pull inward.



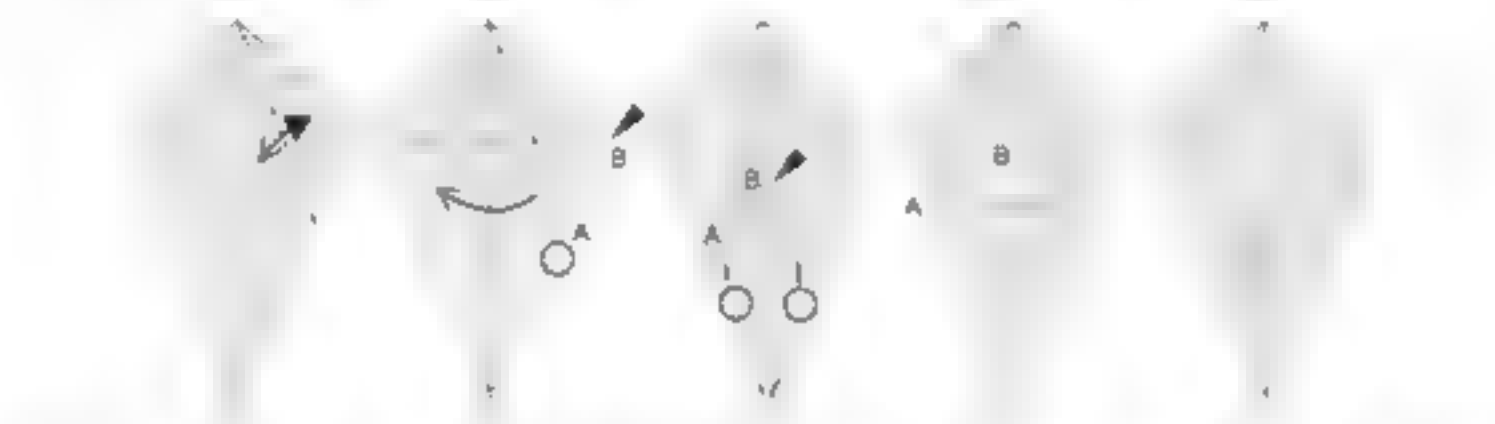
It is also possible to execute an inside petal fold. To do this first execute the petal fold in the regular fashion as shown above, and fold the new point downward. Then pull the model open slightly, push the point up inside the model, and close it back up, hiding the point inside the model.



## Level II - Intermediate

Models at this level require that the folder be comfortable with manipulating paper and following longer sequences of steps. While the techniques used are not difficult, they are challenging enough that they become stumbling blocks for many folders. For example, many folders decline to attempt models which contain "sink folds" because sinking has always been a procedure which confounded them. In actuality, sinks are generally quite easy with practice and increased confidence, but they are nearly impossible if you have not been taught the "correct" way of executing them. Some of the techniques of this level also require the folder to become more aggressive with the paper, requiring a partial undoing of some of what has already been folded in order to move forward. For example, when executing a sink fold to make the procedure easy, it is necessary for the paper to be unfolded partially and then refolded. This can be extremely annoying and counterintuitive to the beginning folder who is used to models in which each step builds upon the last in a logical progression. But as their confidence increases, the procedures become more fluid. Level II is analogous to "Intermediate" on the Organic SA scale and rates a "3" on Juan Montroll's scale.

**Spread Squash** Spread squashes are similar to squash folds except that the bottom of the flap being squashed is not open. The folds can be confusing the first time you encounter them, but they are not much more difficult than regular squash folds. A triangular spread squash can be executed on the edge of a bird base as follows: First precrease the paper, then grab one thickness of the lower part of the flap and pull it to the left. Keep pulling the flap to the left and flatten the paper out completely as shown in the fourth figure. This completes the maneuver. One thing to keep in mind when executing spread squashes is that it is important to make sure that you stay on the desired creases. It is as easy to distort the squashed area as it is to execute the fold correctly. Aligning the fold correctly is similar to executing a normal squash fold, assuring that the squash is symmetrical about the center. An example of a distorted spread squash is shown in the final figure.

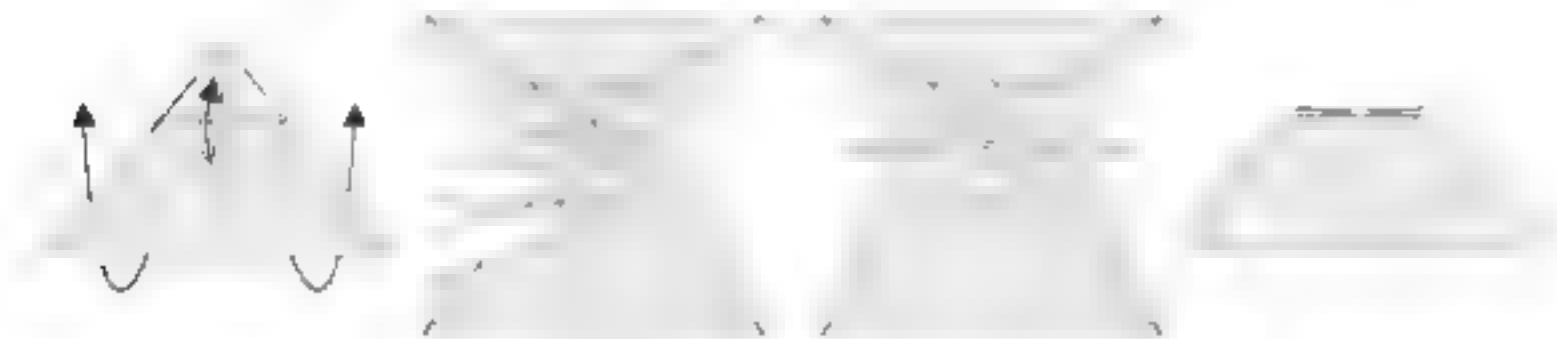


Spread squashes are not always triangular; in fact they can have any number of sides. Below, a rectangular spread squash is demonstrated on a waterbury base. Precrease the base in half and then in half again. Note the location of the four anchor points; they are very important. Place your index fingers on the upper points, under one thickness of paper, and your thumbs on the lower points, above the paper. Pull the upper thickness all the way down across the lower crease while pushing on the center of the upper point with another finger. Doing this will cause the upper fourth of the paper to spread open directly over the center of the model. This fold, unlike the triangular spread squash, is not possible to complete in one motion. Do the best you can with your first attempt, then go back and gently tug and roll the paper to create the desired result. This procedure is likely to be awkward at first, but with practice becomes much easier.



**Sink** Sinks are a stumbling block for many readers, but are an extremely important technique and if executed correctly, are in most cases not difficult. Sinks are significant because they allow the folder not only to hide paper while creating new points and surfaces, but to do so without encumbering any of the rest of the model. Not encumbering paper is very important in creating models because the less encumbered a model is the more options the creator has while folding. Consider a waterbomb base. With a standard waterbomb base it is possible to fold one flap from left to right in front, and then another behind. But if you were to fold the top of the base down, and not fold it back up, the base becomes encumbered and you would not be able to fold the flaps as freely as before. The same is true if you fold the top of the base to the rear. To avoid this you must push the paper down through the center of the model, sinking it. This allows you to hide the paper and still be able to fold flaps from left to right.

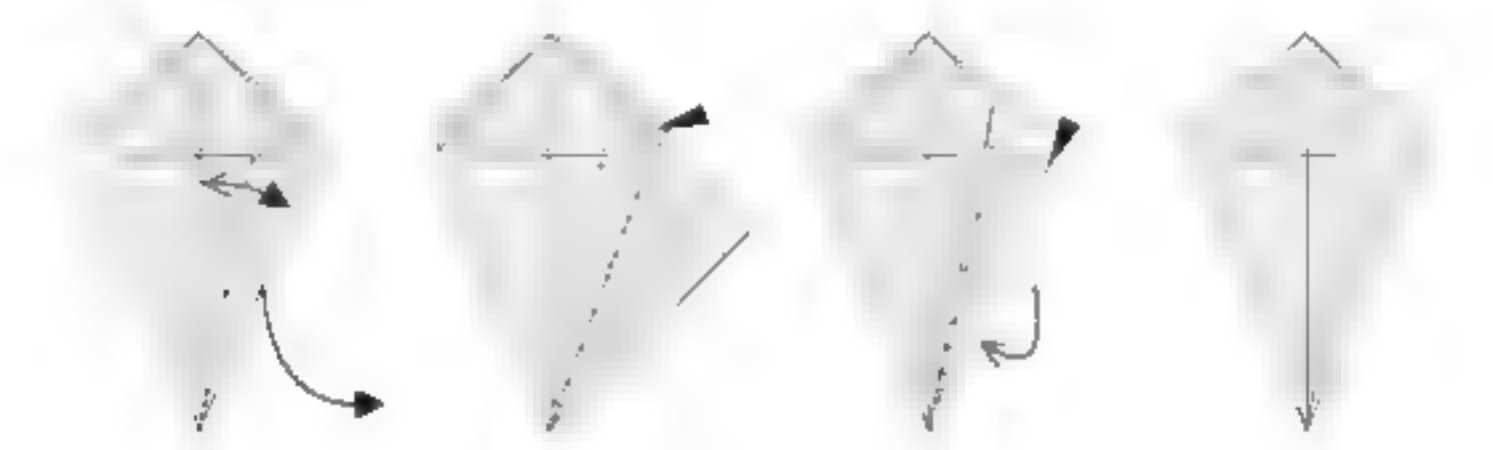
Many beginning readers who have not been taught the proper procedure attempt to execute sinks by literally pushing the paper down through the center of the model, which is nearly impossible. To execute a sink correctly you must first unfold the model enough to create a flat surface out of the area being sunk, then fold the paper back up while pushing the center downward. The proper procedure is described below using a waterbomb base. First, precrease the paper being careful to make very sharp creases. Next, unfold the paper enough so that the area to be sunk can be flattened out. This is likely to be unnecessary for the novice folder. Then, using your thumb and forefingers, crease each of the creases as a mountain fold, creating a flat surface in the center. Once you have done this the rest is easy, just fold the model back together, guiding the center downward as you bring the sides in.



**Sink by Spread Squash** In some cases it is impossible or impractical to unfold the model around the area of the sink. Sinking under these circumstances is more difficult, but by applying the spread squash technique it can be done. Recall that what makes standard sinks easy is opening the paper enough that the area of the sink becomes a single flat surface. In this case the same is true, but the flat area will be created by executing a spread squash. Starting with a waterbomb base, precrease two lines, one at 1/2 and another at 1/4, then spread squash the top as described previously. To complete the sink, simply fold the flap back up, bringing the two side flaps to the center. The result is the same as with a standard sink, with the exception of the additional horizontal crease. As you become comfortable with the technique, it is desirable to execute the spread squash without making the extra crease, as it leads to a cleaner model.



**Pleat Sink** Pleat sinks are a special form of sink where a flap is creased in half, unfolded completely and put back into place by pleating it up like a fan. The result is the same as if the flap were sunk in the conventional mode. Pleat sinks are generally easier to execute than regular types of sinks because they end up consisting of several sequential reverse folds. To execute a pleat sink on the edge of a bird base, first precrease the flap very firmly and unfold it. Next, execute two reverse folds on each of the first two creases. This is equivalent to a crimp fold and can be executed as one if you prefer. The sink is completed with a final reverse fold.

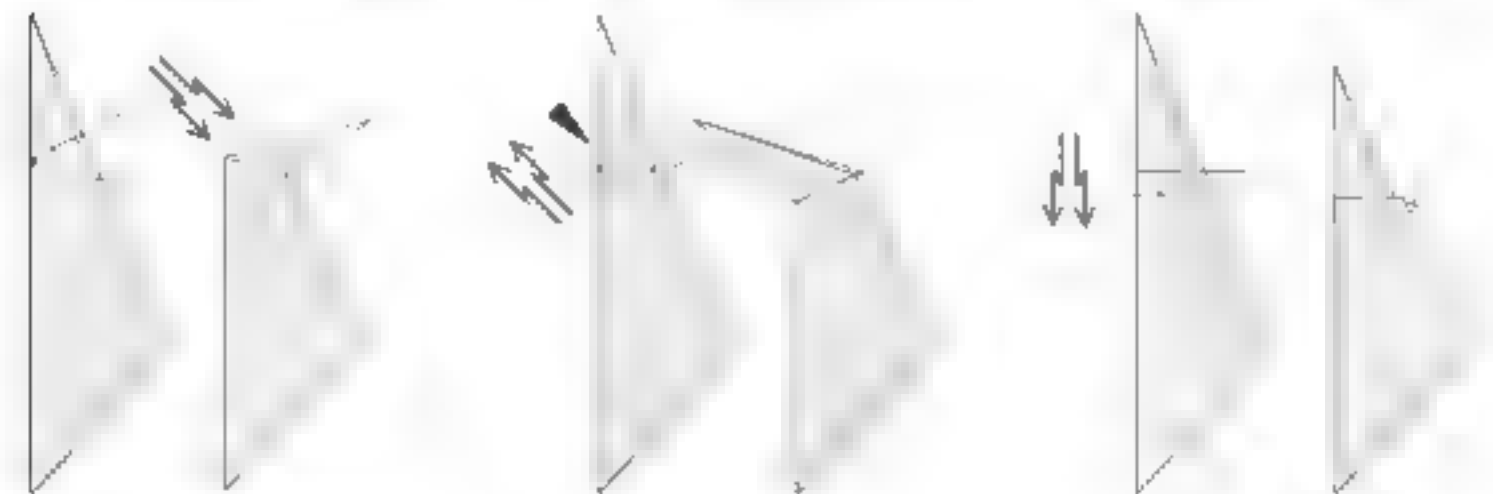


## Level II+ - Advanced Intermediate

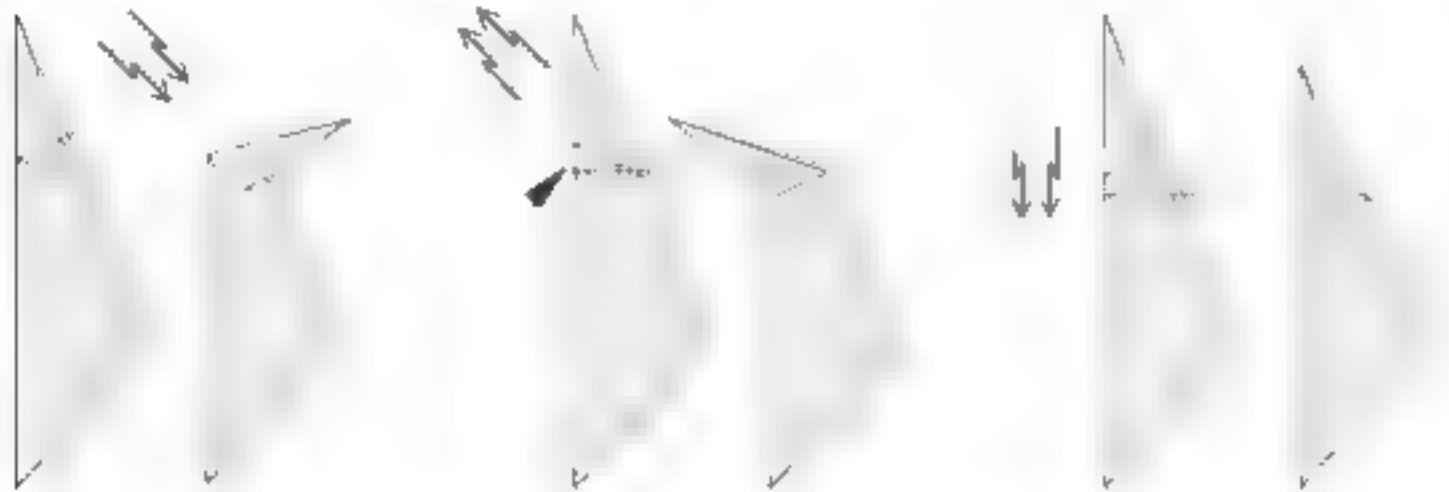
These techniques are similar to intermediate level techniques in what they require of the folder in terms of experience and control with the model itself, but they are somewhat more difficult to execute than the techniques listed previously. Level II+ is analogous to "High-Intermediate" on the Origami USA scale and also rates a "++" on John Montroll's scale.

**Crimp Folds** Crimp folds change the angle of a point and are used in folding ships to create things such as sails, masts, and funnels. Though crimps are common, they can be confusing and difficult to execute, requiring manipulation which is not straightforward compared to other procedures. Some crimps are simple and can be executed by joining two reverse folds, one in one direction and another in the opposite direction, but other crimps are not so straightforward and require more aggressive manipulation of the paper. Because of this, crimps as a whole are designated as Level II+ in origami with the Origami USA system which rates crimps as High-Intermediate.

**Inside Crimp Folds** When executing inside crimp folds, the edges of the paper are positioned so that they lie inside the lower layers of paper. Inside crimp folds are designated by two crooked arrows with their heads closer than their tails. Of the three crimps described below, the first is the most difficult. You may find it easier to execute it by putting one half of the crimp into place at a time using a sharp pair of tweezers to twist the paper into place. The other two crimps are of the simple variety and can be executed with two reverse folds, first on the mountain fold line (after precreasing) and then on the valley fold.



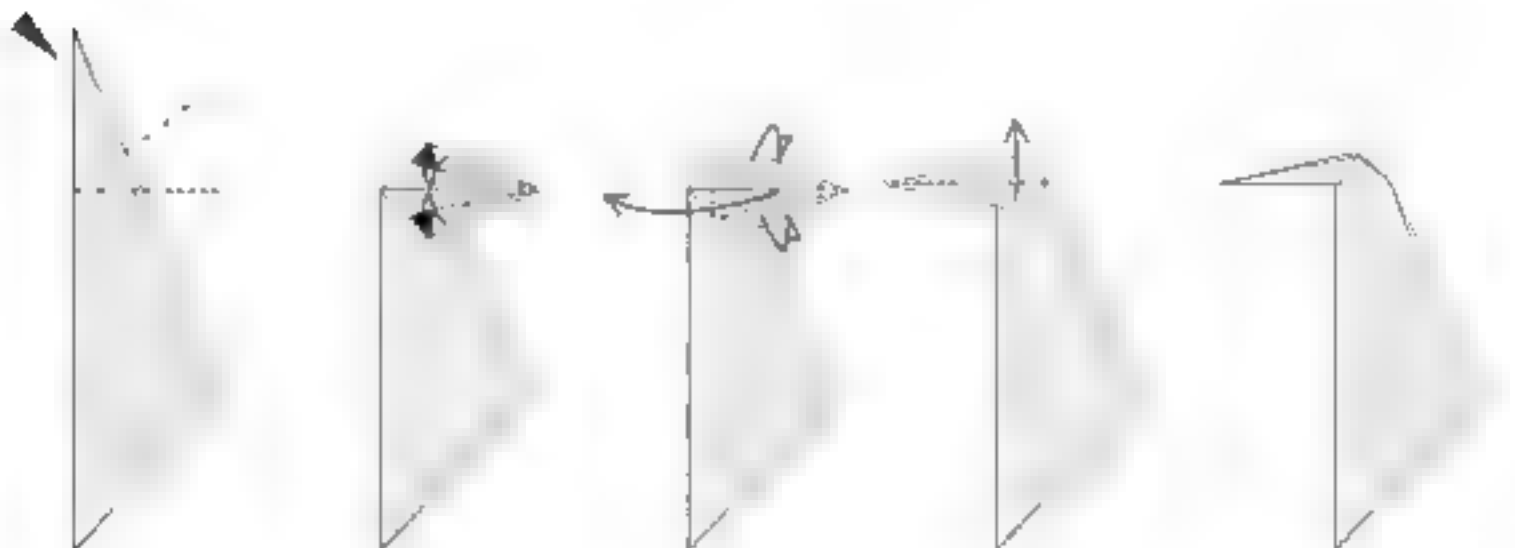
**Outside Crimp Folds** When folding outside crimp folds, the paper is positioned so that the flaps lie outside the lower layers of paper. Outside crimp folds are designated by two crooked arrows with their heads further apart than their tails. The first two illustrated below are of the denture type, and the third can be executed with two reverse folds.



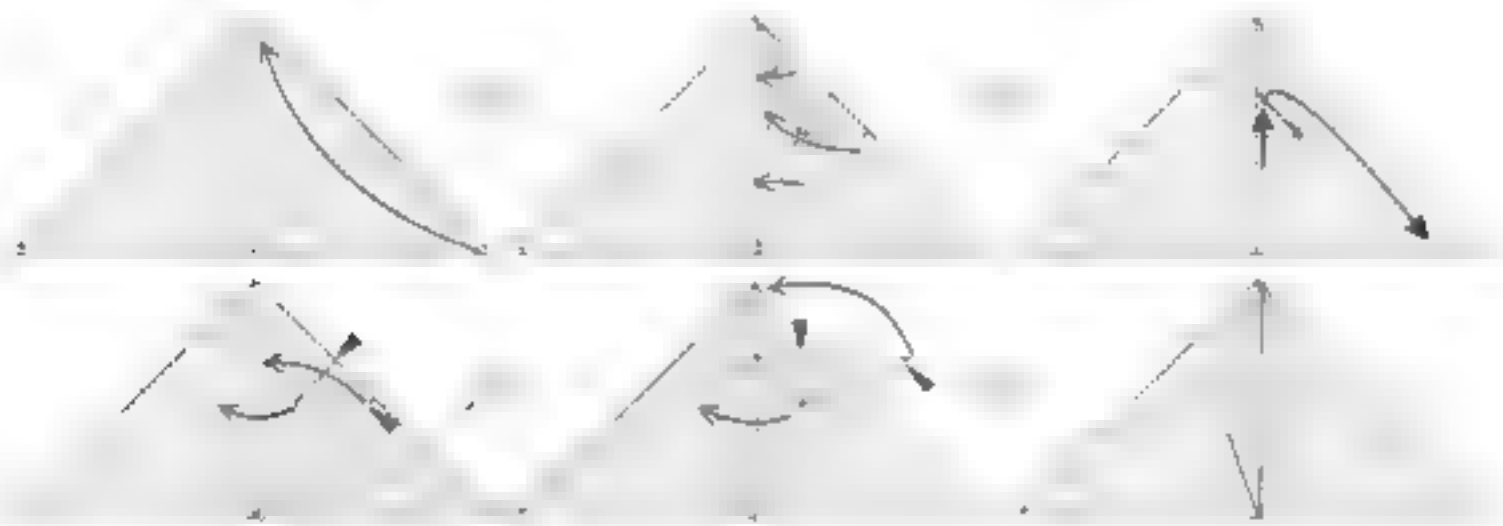
**Crimp Sink** A crimp sink refers to when the paper is sunk in one direction and then again in the opposite direction. Generally, the procedure is executed as two separate sinks, executed independently of each other. More adept folders will be able to execute the sinks concurrently, skipping the 1st step of the first sink and not forcing the model up until the second sink is completed.



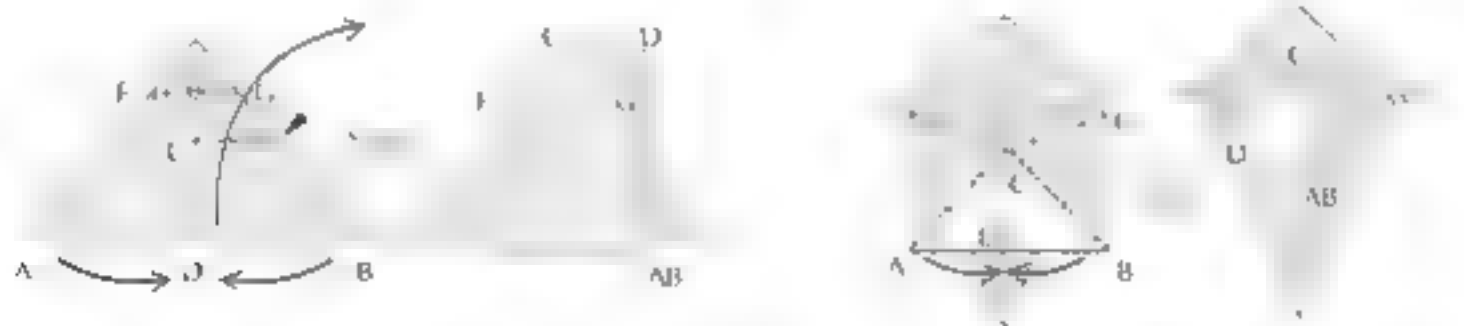
**Double Rabbit Ear** The double rabbit ear is literally two identical rabbit ears being executed simultaneously. If the paper were to be unfolded, the creasing patterns on either side of the rabbit ear would be mirror images of each other. Usually, a double rabbit ear is executed by executing a squash fold followed by a petal fold, but in more complicated models cases exist where the procedure must be executed in one motion.



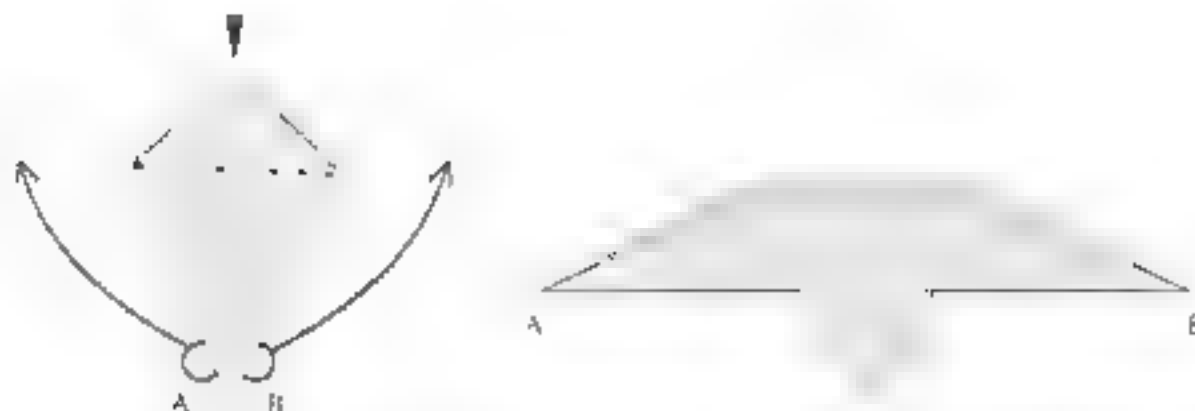
**Quadruple Rabbit Ear** The quadruple rabbit ear like the double rabbit ear contains multiple rabbit ears which are being executed simultaneously. But in this case there are four rabbit ears, not two. The creasing structure of a quadruple rabbit ear is identical to that of a bird base. In fact, the bird base is a special case of a quadruple rabbit ear which has been executed on an entire piece of paper rather than just one flap. The procedure is demonstrated below on one flap of a waterbomb base. Carefully fold the flap in half and very accurately fold a rabbit ear through both thicknesses, being extremely careful not to let the inner thickness slip out of place. Next, fold the flap point down and back up, and unfold the flap completely. This completes the precreasing. Now, execute a double rabbit ear on the inner set of creases, spreading the paper flat, and then fold another on the outer set of creases. This results in a bird base like structure formed on the entire flap. It is also possible to execute the procedure on just a portion of the flap, say halfway down, which results in a smaller bird base which is further from the center of the model.



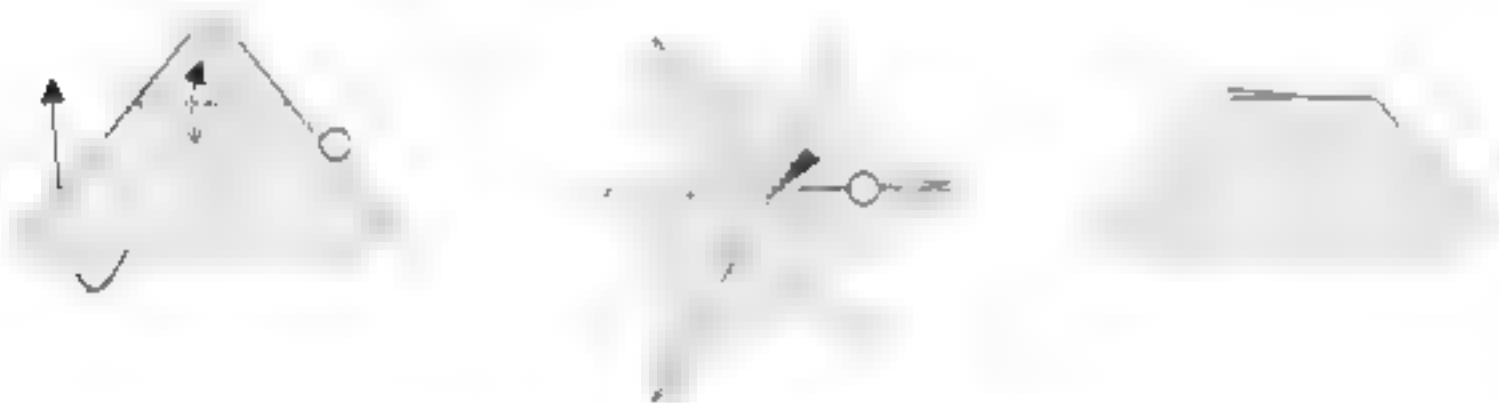
**Double Swivel Fold** Double swivel folds are simple constructions which are used frequently in computer models, particularly those by John Montroll. A double swivel fold consists of two swivel folds sharing a common central vector, which are executed simultaneously. In both of the examples below, swivel folds are being executed along EC(D) and GC(D) which share the common vector C(D). The first example shows the procedure being executed on a waterbomb base, and the second example shows a more natural reference, which has been taken from the Tazarakian Dragon. In both of these constructions, points A and B are being brought together and triangle ECG is being flipped upward. As you execute these folds, concentrate on rotating triangle ECG and guiding it into position as while matching A and B together. This procedure, as with petal folds and sinks, can easily become a stumbling block, but once mastered, becomes trivial to execute.



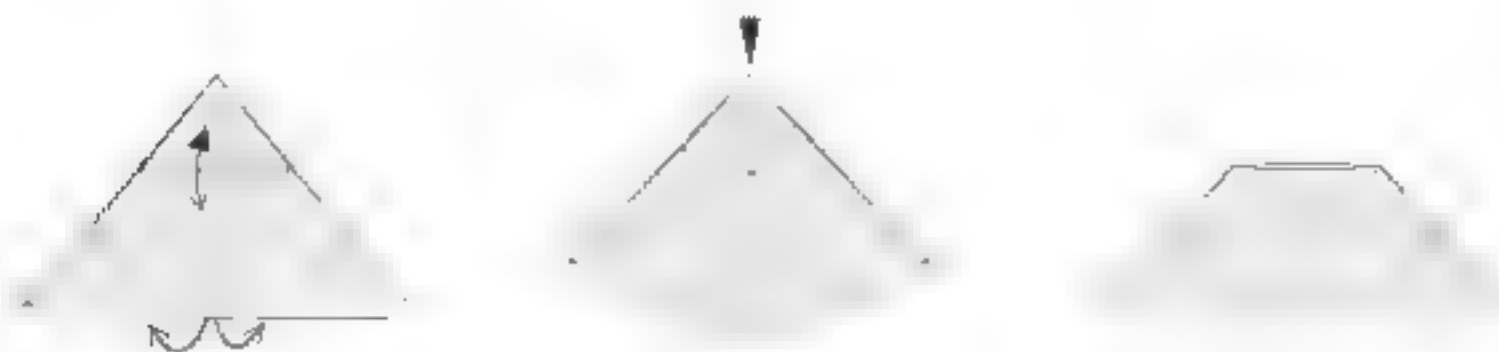
**Stretching a Base** Stretching a base is somewhat similar to a construction. It involves taking a familiar form, unfolding it partly, and reassembling it in a different configuration on the existing creases. Stretching a base is generally not difficult to do after you have successfully completed it once. To stretch a bird base, grasp the two inner flaps of paper and pull them all the way out to the sides, then flatten the paper out on the existing creases, making one long valley fold from point A to B. Two extra creases will need to be added under the "wings" to get the paper to lie flat. Bird bases are the most commonly stretched bases.



**Non-rectangular Sinks** Sometimes models will call for sinks which are not strictly rectangular or will require sinking the paper in such a way that some of the paper (but not all of it) becomes encumbered. In these cases the directions will tell you what type of shape you are creating, triangular, pentagonal, star, etc. or whatever the case may be. In the example below, the top of a water bomb case is sunk triangularly encumbering one of the flaps. To execute the sink proceed as you would with a regular sink, but when you open up the paper keep two of the flaps pinched together as if they were one thickness of paper. When you execute the sink you will have to push the paper through the center before rolling the model up. It is not possible to create a single continuous flat surface as with regular sinks. Notice in this final illustration that the two right flaps have become encumbered while the left flaps remain free.



**Closed Sink** This technique is a special case of the non-rectangular sink where all, or some, of the flaps are encumbered and the shape which is created has only two sides. Geometrically there is no such thing as a two sided shape, but in the applied geometry of origami it becomes a fact. Therefore, to execute a closed sink, it is necessary to take a portion of the paper and literally push it through a slot in the model. This can be very difficult and is especially hard to do neatly. To make the procedure easier, it helps to make the model as 3D as possible, maximizing the size of the opening. It might also be easier if you "soften" the top of the region which is to be sunk by rolling it between your thumb and forefinger. It may also be necessary to "mean up" the sink from the other side after executing the procedure, depending on the requirements of the model.



**Inaccessible Sinks** Inaccessible sinks are some of the most difficult folds in the realm of paper folding. They are sink folds of any type where it is not possible to unfold the model and get your fingers "behind" the area that is being sunk. Needless to say, these sinks are rare and only occur in models which are complex enough that there are so many intertwined layers that the paper cannot be unfolded. The best way to approach them is to sink with the spread/squash method, because it allows the folds to sink without unfolding the model. But remember as you do the sink to make the guiding lines lightly or not at all, so that there will be no extra creases created on the paper.



**Wraps** Wraps are a special form of closed sink where a portion of the paper is wrapped around part of the model to "hide" it. Wraps are usually used to hide portions of the internal structure of the model and to create smooth, pleasing surfaces. Below, a wrap is executed on a water-bomb-like shape which has had a double rabbit ear executed on one flap.



## Level III/III+ - Complex/Very Complex

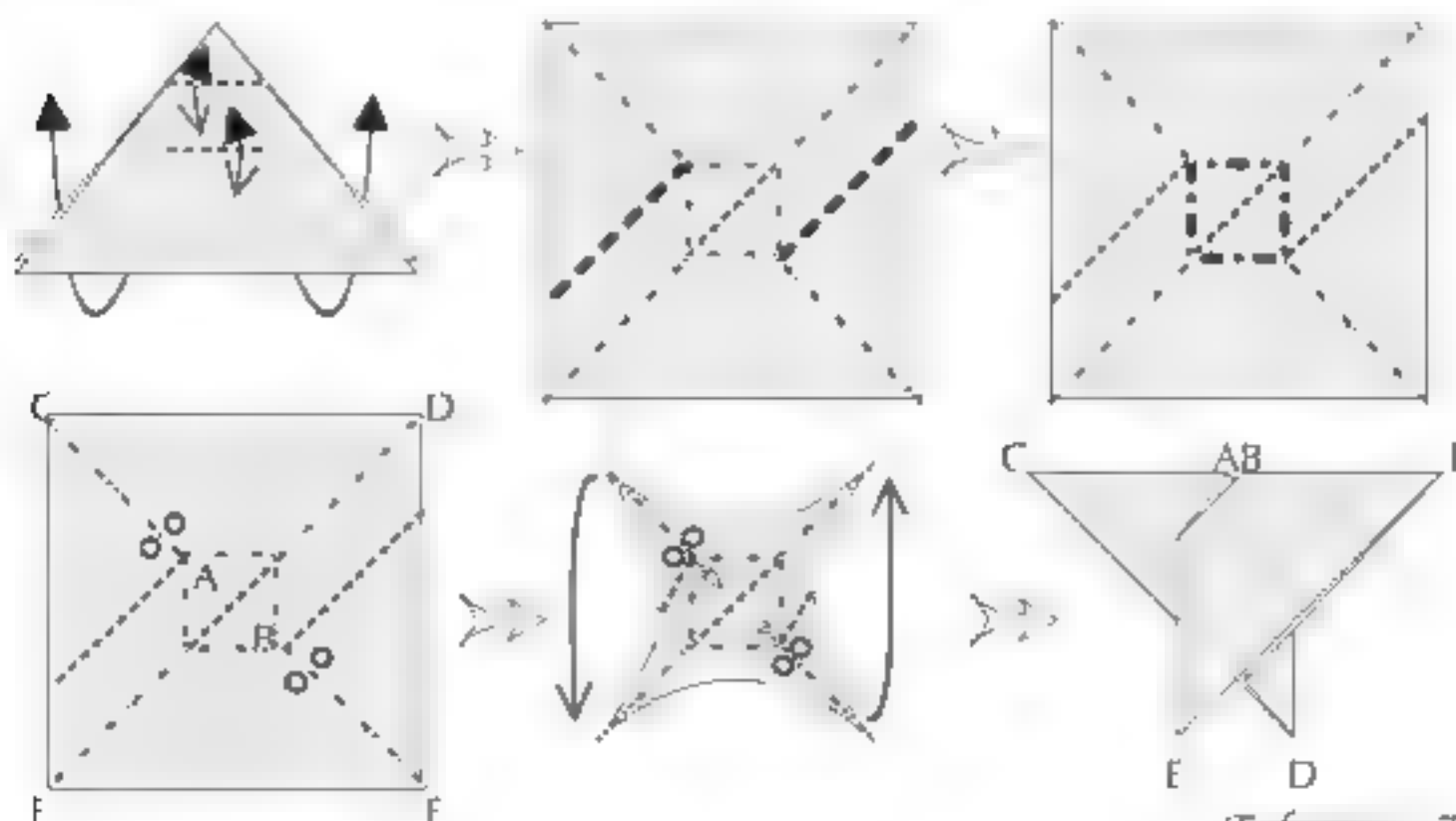
The primary difference between models which are rated intermediate and those which are rated complex lies in the fact that the folding can no longer be broken down into straight forward procedures. All models of lesser difficulty levels can be broken down into a succession of some combination of known techniques which can be learned by the folder and mastered, such as petal folds and sinks. But in complex models, the procedures are more abstract. It becomes necessary for the folder to decipher steps which consist of many creases being made in many directions simultaneously, or even more challenging, unfolding or rearranging unspecified portions of a model until it matches the next illustration. This type of folding requires the utmost confidence and familiarity with the medium and each step can become a jizzie in its own right. The distinction between III and III+ lies in the level of analysis that is necessary to complete the folds. Complex models are not much more difficult than high intermediate models, but they are likely to include sequences with which the folder is unfamiliar. On the other hand, when folding a very complex model, the folder is likely to encounter sequences which are not only challenging to decipher, but may also be extremely difficult to pull off physically without causing serious damage to the model. All of the techniques listed here could appear in a Level III model, with the exception of "sinking a double layer." But if the sequences are particularly difficult, or in great number, the model should be rated a III+. Level III is analogous to models graded "Complex" on the Origami USA scale and to "\*\*\*\*" on John Montroll's scale. Level III+ is analogous to models graded "High Complex" on the Origami USA scale and to "\*\*\*\*\*" on John Montroll's scale.



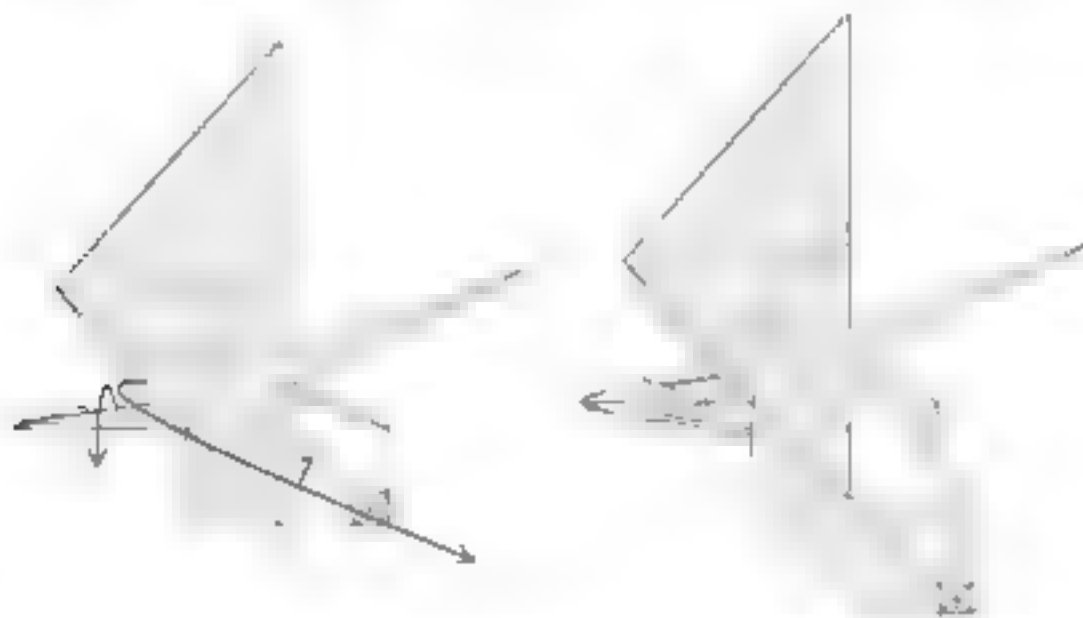
**Constructions** Constructions are complex structures that are created by executing many folds simultaneously. They exist primarily as shorthand for diagrammers and in most cases, are actually simple and intuitive if you understand their purpose. When diagramming, it is often easier for both the diagrammer and the folder if the diagrammer shows a series of steps as an amalgam of all the creases which are being created instead of the actual steps that were used to get there. This is true because in some cases the actual folds are vague enough that they would be very difficult to describe precisely and what really matters is that the end result be reached, not how you got there. Constructions are challenging, but if you know a few simple guidelines they become less complicated. First be sure to precrease very carefully and thoroughly. It is important that each crease (mountain and valley) be in place and oriented in the proper direction. Pay special attention to the mountain folds in the construction, they are generally the more difficult ones to place and will have a greater impact towards finding the correct structure. Be patient — it is almost always the case that after fiddling with the paper for awhile, it pops naturally into place once you find the key vectors which compose the construction. Think of the construction as a puzzle, remember that it is probably just shorthand for a more complex series of steps.

Try to second guess what the creator is trying to accomplish, the fold may become trivially easy. When folding Robert Lang's *Housefly* I encountered an extremely complicated and difficult construction. I spent twenty minutes trying to decipher all the vectors in the figure but had no success. Finally I looked ahead to the text several steps and got a sense of what the construction was intended to accomplish. Then I closed the book and fiddled with the paper, keeping in mind what the fold was to do. After a few minutes the construction fell into place. I then went back to assure that I had included all base cases. It turned out there were some extra folds which were not part of the main construction which I had not picked out. They were extra folds which had no effect on the end of the model, but they were distracting enough that they had prevented me from deciphering the original form.

In the example below, butterfly base is created. The base was originally made by sinking a waterbomb base and then swiveling the sides of the sink together and flattening out the paper. But the form is easier to describe with a construction. Start with a waterbomb base and crease lightly at 1, 2 and then sharply at 3, 4 and flatten the paper completely. Next, add the two missing vectors shown with the marked  $\Delta$  and recreate the mountain folded square in the middle so that the folds are oriented in the proper direction. With this particular construction, the objective is to bring points A and B together. Notice that these key points are surrounded by mountain folds, as I stated would usually be the case. Once the model where indicated and push the two points together. As you flatten the model out, the rest of the creases will fall into place.



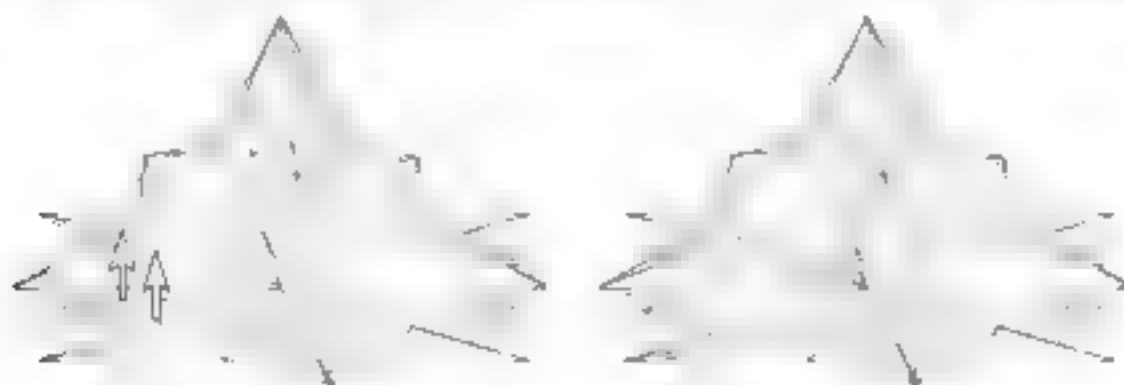
**Pull Out Some Loose Paper** In this procedure, some of the model is being unfolded so that the disencumbered paper can be used to create another portion of the model. In many cases this procedure is straightforward and does not warrant grading the model as complex, but in other cases the procedure is complicated and the only clues given as to how much paper to unfold are the before and after illustrations. The example below is from the "Frost Dragon."



**Color Changes** Color changes refer to any sequences where the object is to take some portion of the model and let it loose and usually to change the color of the paper. The example below taken from Barbara Crayford's "Square in a Box" is similar to a wrap with some added folds. Other cases involve one or more reverse folds, single or multiple sinks being executed simultaneously or unfolding the paper and reassembling with a complex construction.



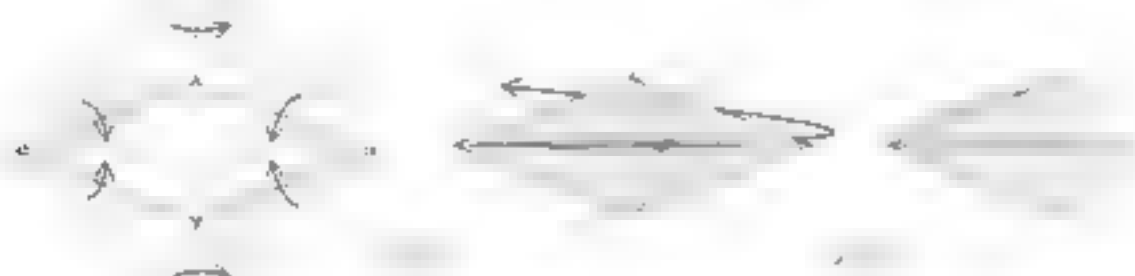
**3D Manipulation/Unsinking a Double Layer** Two other procedures that can make a model to be graded complex are illustrated below. The first occurs in models where a large portion of the folding is done in 3D and the model must be manipulated in that state. The other occurs when a single layer of a double thickness of paper must be separated from the other. This is very difficult, particularly when the space between the layers is inaccessible. The example below is taken from the "Sea Anemone."



## Traditional Bases

One of the simplest and least stressful methods of creating new origami forms is "Doodling." This is done by taking a standard base or an intermediary step of another model and playing around with the paper until something interesting happens. Many of my early models were created this way, including the spider series, the Tarantula, Wolf Spider, Dragonfly, and Octopus, as well as Andrea's Rose. This section has been included to give the prospective doodler tools of ammunition. The first shown are the traditional bases which are ancient in origin and can be found in one form or another in nearly all origami models created prior to 1975.

**Fish Base** This is the simplest of the traditional bases. It is created by folding a two flap ears on a square of paper.



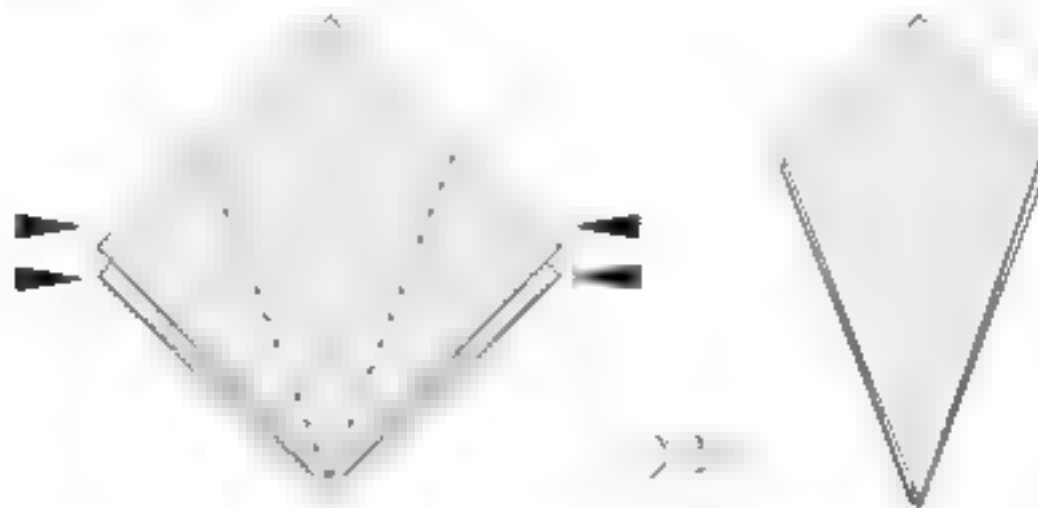
**Preliminary Base** Also called the diamond base, the preliminary base is probably the most commonly used base in traditional origami forms. It is an intermediary step of both the bird and frog bases and for this reason some feel that it is not a true base and refer to it instead as the "Preliminary Fold." It is formed by creasing the paper laterally in both directions, creasing the diagonals in the other direction and then collapsing on the creases.



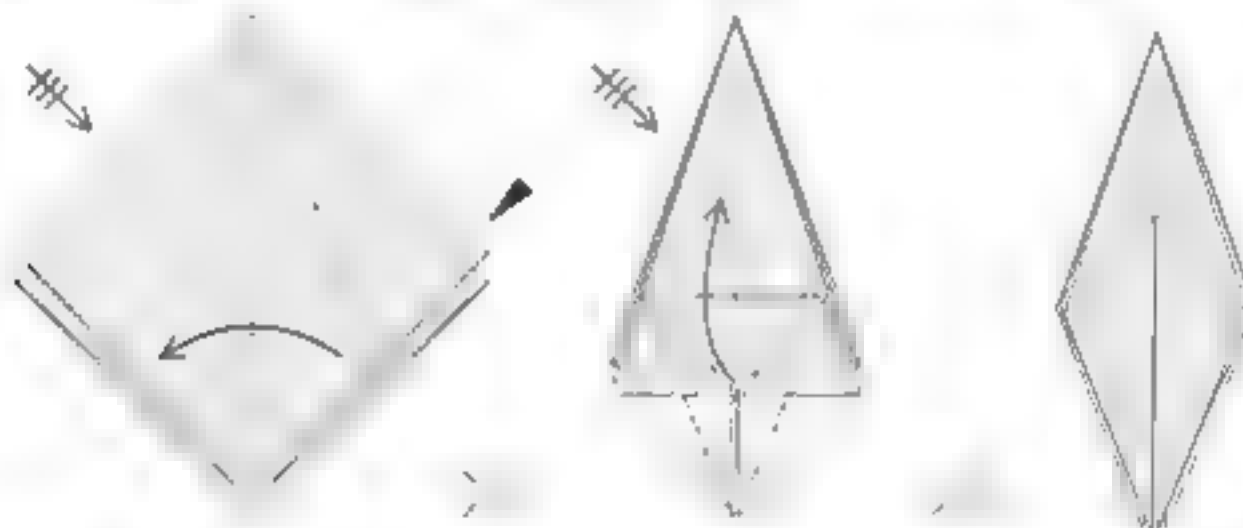
**Waterbomb Base** The waterbomb base is named from the classic "Waterbomb" model which is created from it. As a base it is very common, but not quite as prevalent as the preliminary base. Some feel that the classic bases have been explored to the point where nothing interesting can be derived from them. On the contrary, think the waterbomb base and its derivatives are underutilized and contain many undiscovered forms. The Frost Dragon, for example, is created from a variation of the waterbomb base. The waterbomb base is constructed by creasing both diagonals in one direction, creasing laterally in the other direction, and then collapsing on the creases. It is also interesting to note that if a preliminary or waterbomb base is created by creasing in all four directions and is turned inside out, the other base will result. This occurs because the waterbomb and preliminary bases have geometrically inverted creasing patterns.



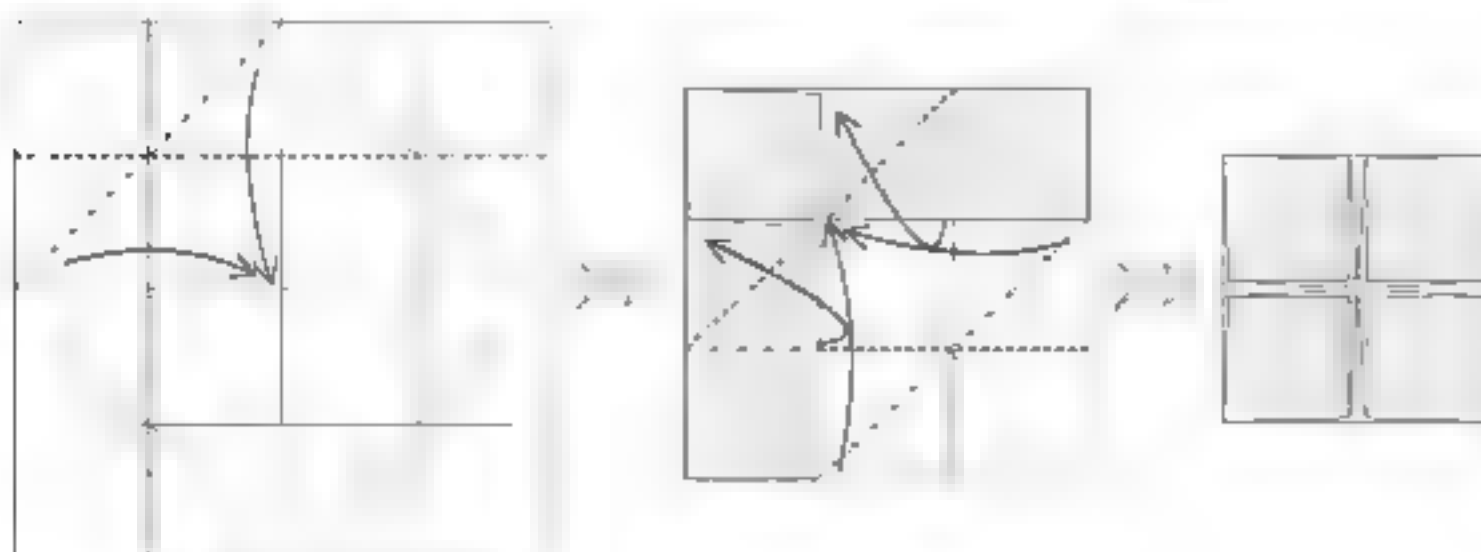
**Bird Base** The bird base is an extension of the preliminary base. It is used in the traditional origami "Crane". Normally it is created by executing two petal folds on either side of the preliminary base, and prefer to construct it by executing a reverse fold on each of the four flaps. This is structurally equivalent and eliminates an unnecessary lateral crease.



**Frog Base** The frog base is also an extension of the preliminary base and is used in the classic "Jumping Frog". It is created by squash folding and then petal folding each of the preliminary base's four flaps.

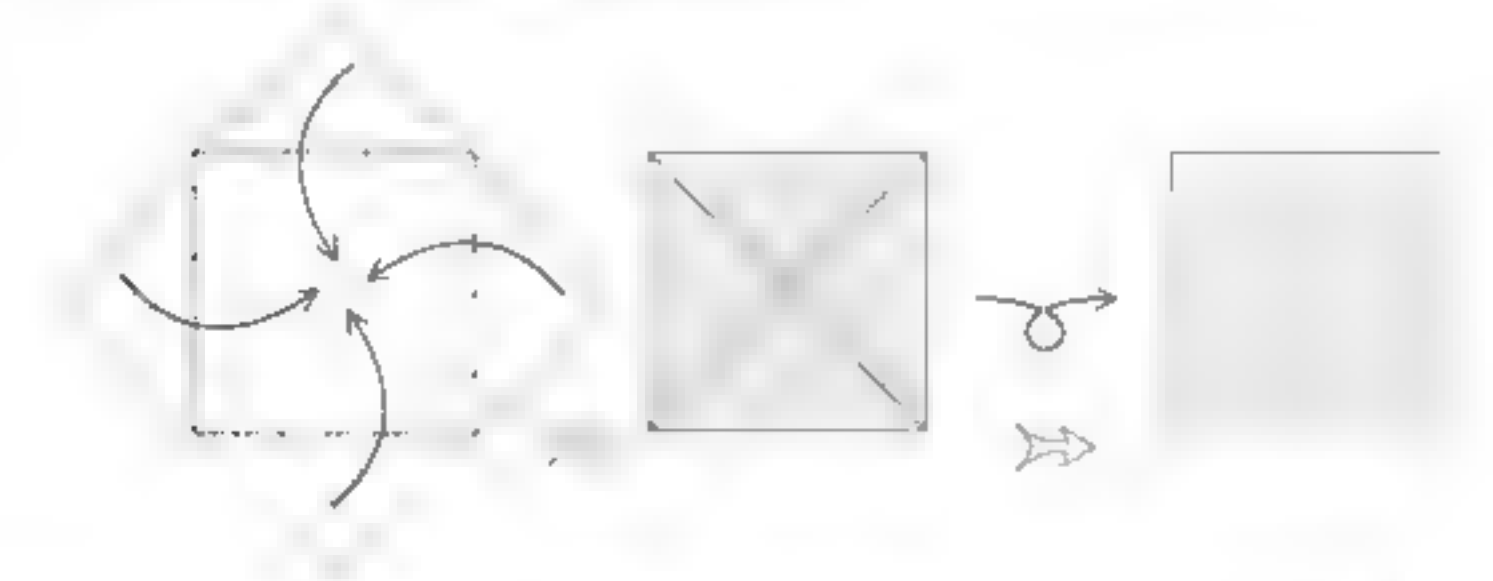


**Windmill Base** The windmill base is used in many of the classic "Decorations". It is created by folding four preliminary bases on a single piece of paper. It is somewhat more difficult to fold than the other traditional bases and can be confusing the first time one attempts it. The windmill base is used in "Andrea's Rose" and "Branded Paper". A variation of it is used in the "Clown Fish & Sea Anemone".

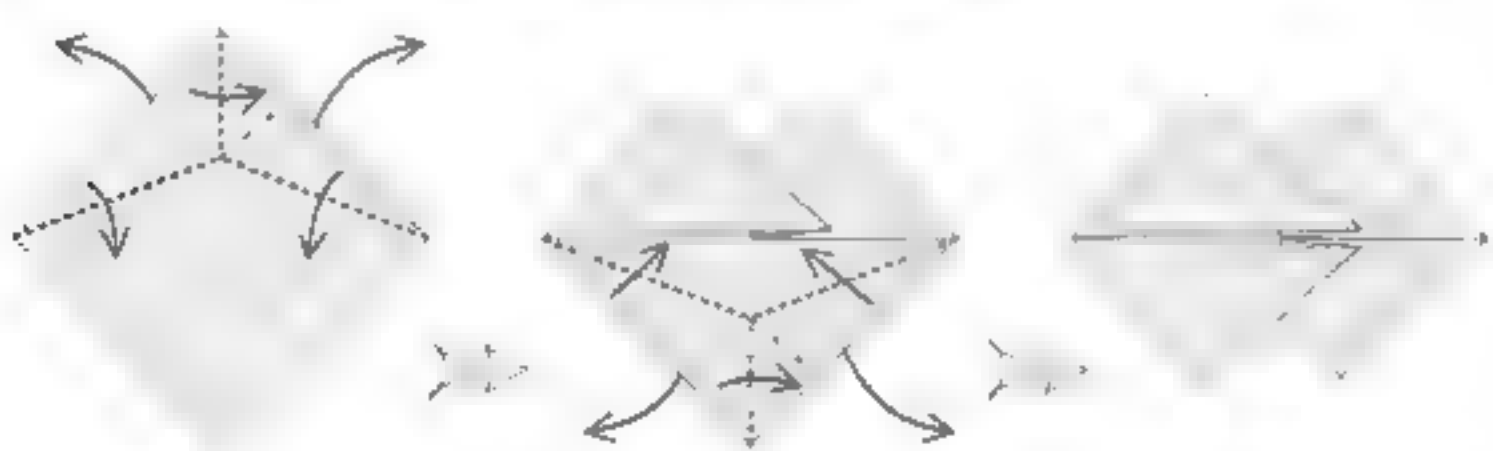


## Blintz Bases

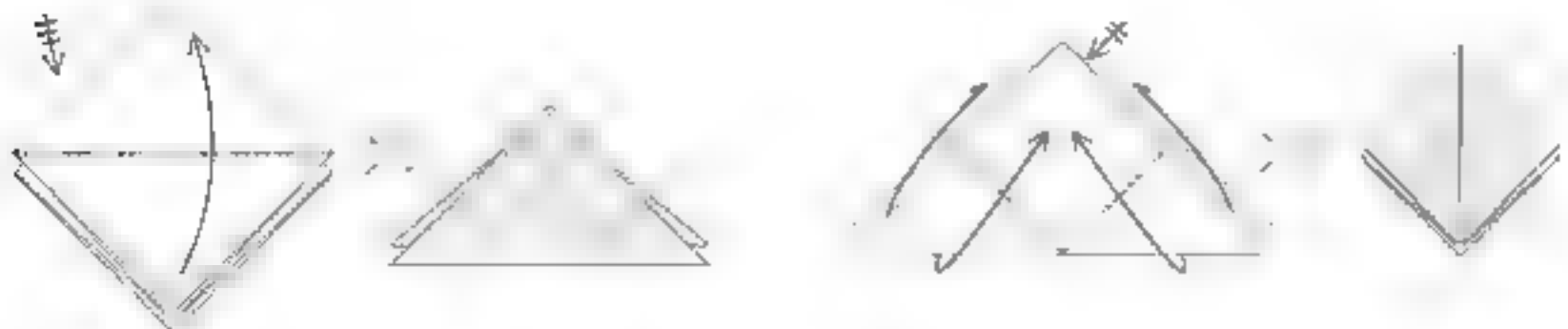
Blintz bases are variations on the traditional bases where the paper is blintz folded prior to folding the base producing a base with more flaps. While some blintz bases are more interesting than others, they are on a whole underutilized. Each of the bases described in this section starts by blintzing the paper as shown below and turning it over prior to folding the actual base.



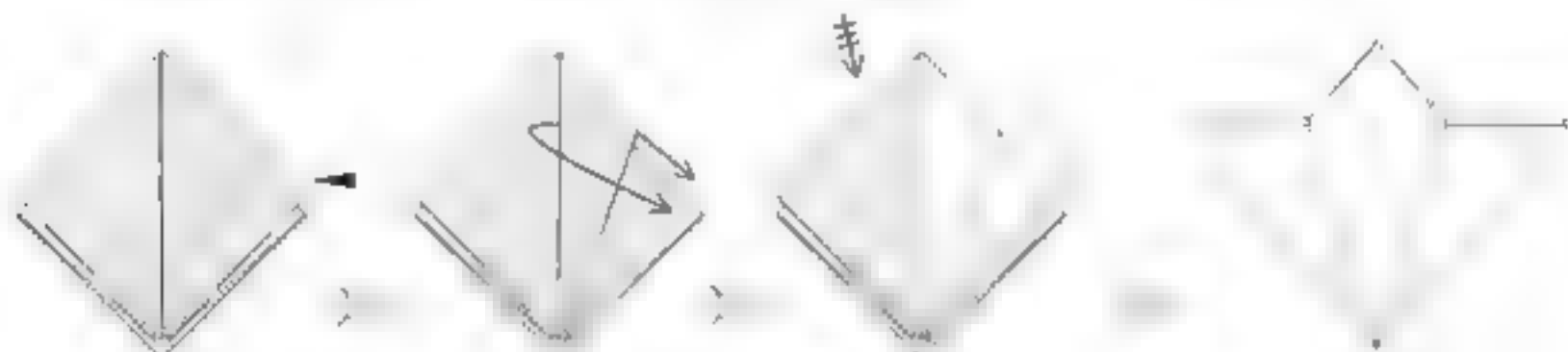
**Blintz Fish Base** I have never seen this base used, but I have seen it described, at least by the author. Start with a blintzed piece of paper which has been turned over, and fold the standard fish base, allowing the rear flaps to swing outward as you execute the rabbit ears.



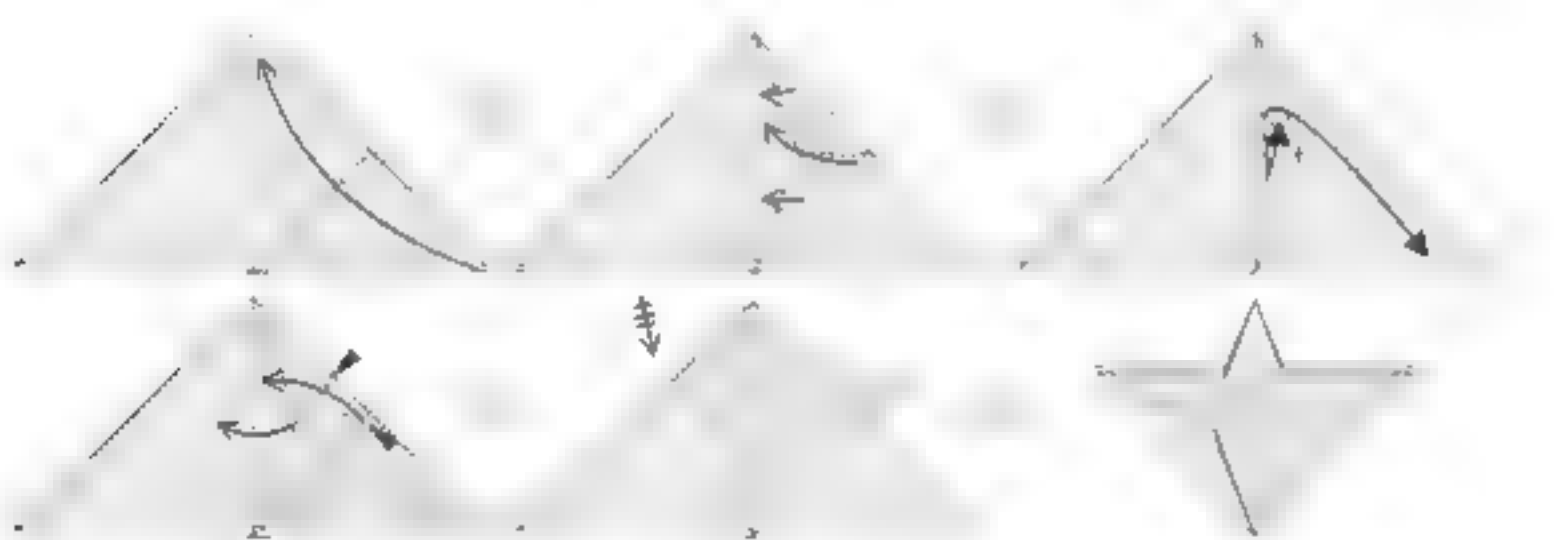
**Blintz Waterbomb/Preliminary Bases** Because of their simple structure and the fact that they are geometric inversions of each other, the blintz waterbomb and preliminary bases are not particularly interesting. In fact, the easiest way to fold them is to start with the opposite base and execute four reverse folds. In the case of the blintz waterbomb base, start with a preliminary base and fold each of the four flaps upward. To create a blintz preliminary base, start with a waterbomb base and outside reverse fold each of the four points.



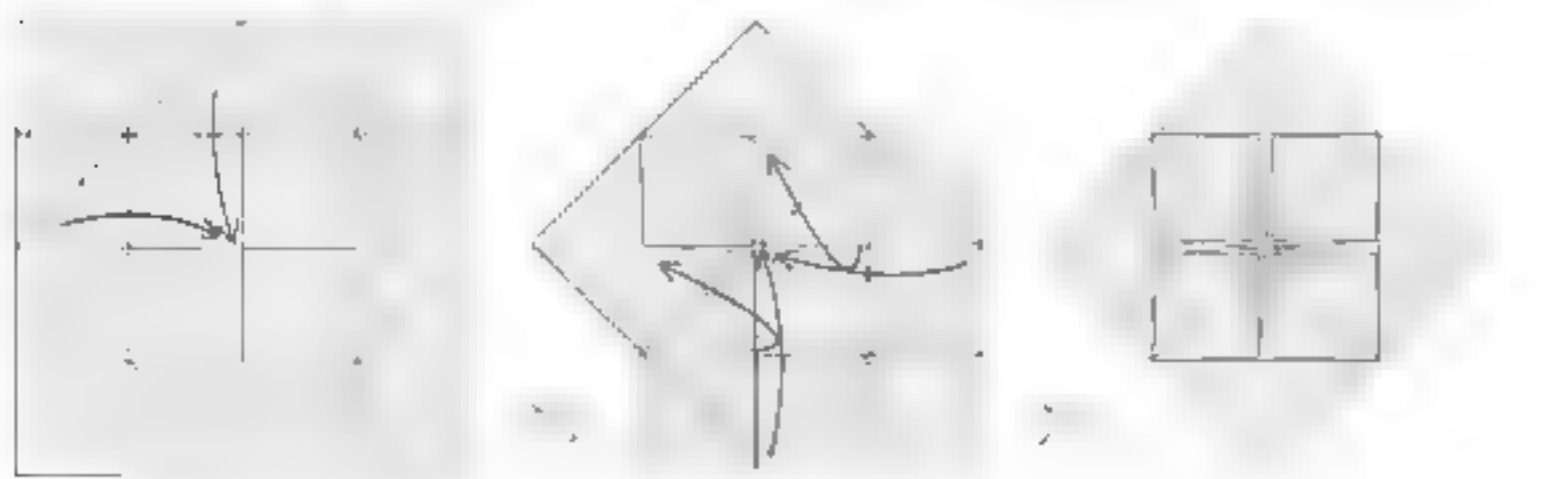
**Blintz Bird Base** The blintz bird base is probably the most commonly used blintzed base. There are many ways to diagram the folding, and most of them are confusing. Hopefully the method illustrated below is simpler. Start with a blintzed preliminary base. Reverse fold one of the four flaps as if you were folding a regular bird base, then outside reverse fold the single ply layer that is wrapped around the flap. Repeat this procedure on the remaining three flaps.



**Blintz Frog Base** The blintzed frog base is the same as a standard waterbomb base, upon which a double raincoat has been executed on each of the flaps. It is uncommon in traditional origami, but raincoats appear occasionally. To fold the base, start with a standard waterbomb base and fold one of the four flaps upward. Fold a raincoat through the entire flap and then unfold. Next, execute a double raincoat on the opposite set of creases. Repeat the process on the other three flaps.



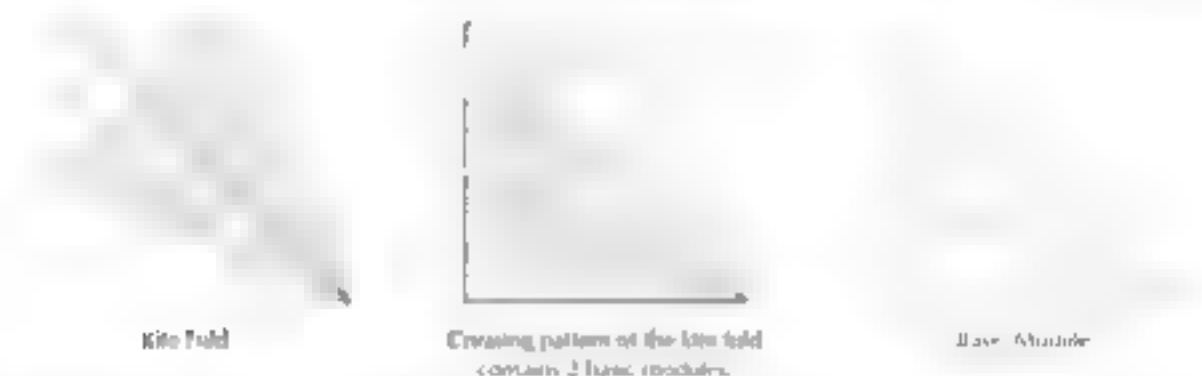
**Blintz Windmill Base** I have never seen this base used or described anywhere, but it is the basis of my "Brown Fish & Sea Anemone." There is no shortcut to folding it; it is best simply to reduce it by folding a standard windmill base on a blintzed piece of paper, allowing the flaps to swing out from around as you execute the preliminary folds.



## The Internal Structure of the Traditional Bases

Though it may not be intuitive at first glance, the traditional bases are closely related from a geometric perspective. If each base is folded and unfolded, and their creases are analyzed, a fundamental pattern can be found repeated over and over in each base. The purpose of this section is to study that relationship and perhaps discover some new bases or at least learn something about the fundamental geometric relationships found in origami.

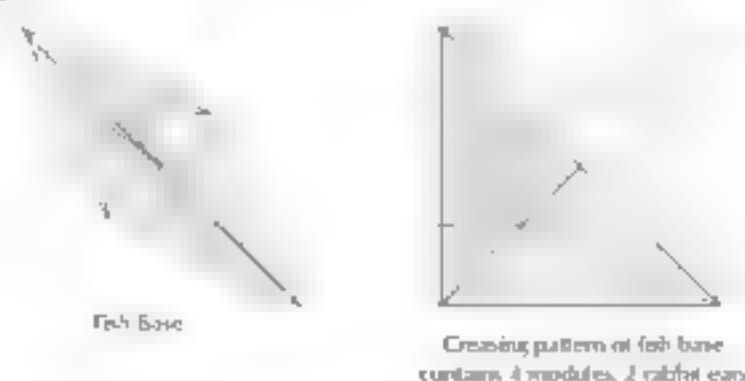
The simplest form of the pattern can be found in comparing the crease patterns of the kite fold and the base. The kite fold, or kite base as it is sometimes called, is created by folding two adjacent edges of the paper to meet in the center. If one unfolds a kite fold and notes the locations of the creases, a fundamental geometric pattern (or module) can be found. This module actually appears twice reflected through the diagonal axis. One occurrence of the module is shown highlighted in gray.



If you then fold a rabbit ear on a single flap of paper, the resulting creasing pattern will also contain two modules, but this time the modules will be reflected through the other diagonal axis. This appearance of the reflected modules across the different axes is extremely important, and is repeated throughout all of the traditional bases.



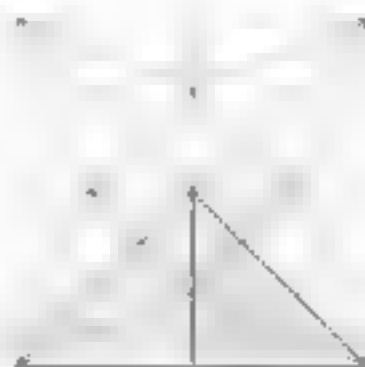
The fish base is composed of two rabbit ears on either side of a single piece of paper. In a very real sense, the fish base is a double rabbit ear, and if you unfold it, the creasing pattern of two identical rabbit ears can be seen reflected through the diagonal axis. If the pattern is analyzed, the same basic module can be seen repeated four times, reflected through each of the diagonal axes. It is not surprising since we've already shown that a single rabbit ear contains two basic modules, it stands to reason that a double rabbit ear would contain four.



The pattern increases in the bird base which is literally a quadruple rabbit ear. It contains four identical rabbit ears reflected through each diagonal axis and if unfolded, is revealed to contain a total of eight modules, which is logical, since it contains four rabbit ears, each containing two modules. Additionally the structure of the fish base can also be seen reflected in the bird base. If you analyze the creases, you will see it cut in half diagonally (a single rabbit ear) rotated 45 degrees, and reflected four ways through the diagonal axes.



Bird Base

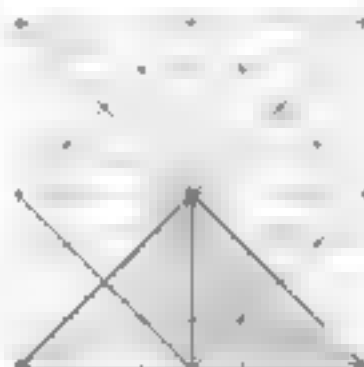


Creasing pattern of the bird base, contains 4 rabbit ears, 8 modules and four reflections of the fish base

The pattern progresses further in the frog base wherein the numbers double again. In the creasing pattern one can find a total of 8 rabbit ears, containing 16 modules, and one-half the bird base (a double rabbit ear) rotated 45 degrees and reflected four ways through the diagonal axes. Also, four occurrences of the creasing pattern for the fish base can be seen in each of the four quadrants of the paper.

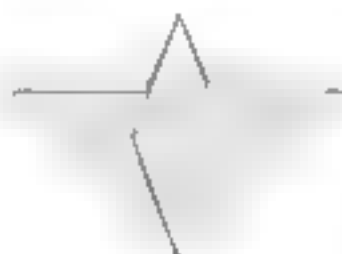


Frog Base

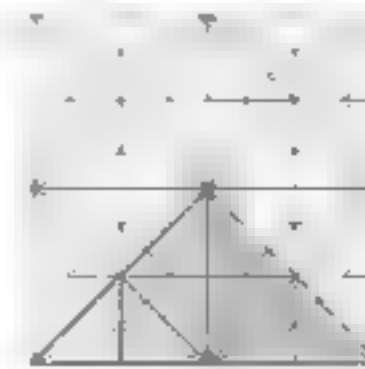


Creasing pattern of the frog base contains 8 rabbit ears, 16 modules, four occurrences of the fish base and 4 reflections of the bird base

This progression of doubling can progress forward infinitely. With each successive level the number of modules doubles, the pattern of the previous level appears four times, rotated and cut in half, and four occurrences of the pattern two levels previous will appear in each of the four quadrants of the paper. The next step in the progression is found in the blintz frog base which contains 16 rabbit ears containing 32 modules. Note also, four occurrences of the frog base halved and rotated, as well as an occurrence of the creasing pattern for the bird base in each of the four quadrants.



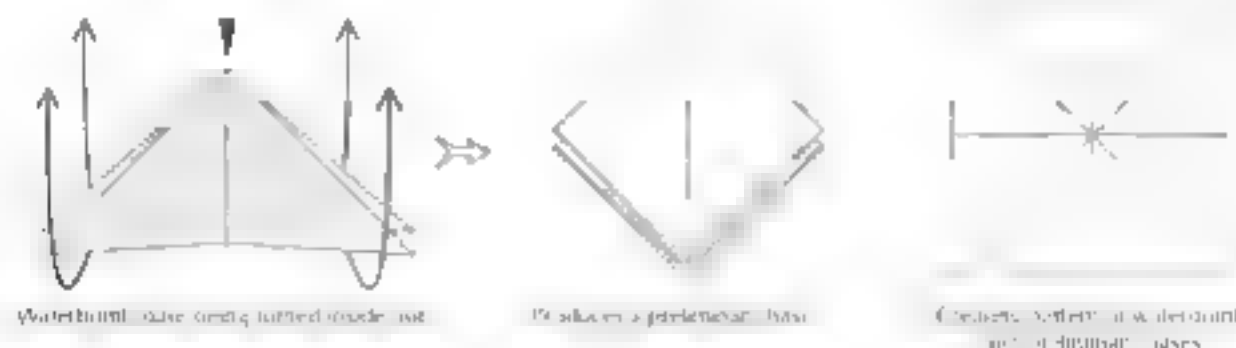
Blintz Frog Base



Creasing pattern of the blintz frog base contains 16 rabbit ears, 32 modules, 4 occurrences of the bird base and 4 reflections of the frog base



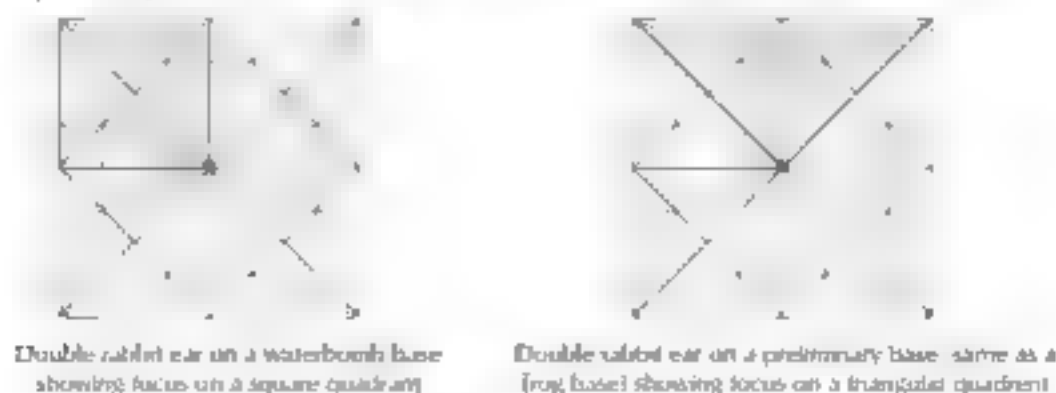
The waterbomb and preliminary bases are also closely related but in a different way. They are geometric inversions of each other, which means that they contain exactly the same creases except that the direction of each fold is reversed. To illustrate the relationship, fold a waterbomb base, creasing in all four directions and pull all four flaps upward while pushing downward through the center. As the base turns inside out, it springs into the form of a preliminary base. This relationship becomes extremely important in subsequent explorations.



There are also useful facts to observe in the creasing patterns of these two bases. Note that in a waterbomb base, the creasing pattern reveals four perfectly equal squares. If you look at the source of these squares you will see that each makes up one flap of the base. It is as if the waterbomb base were actually four separate pieces of paper, each of which were folded in half diagonally and attached by the edges. The illustration shows this relationship of a single flap with regard to the entire base. A similar relationship can be found in the flaps of the preliminary base, except that each flap represents one-half a piece of paper reflected through the diagonal axis four ways. This is symptomatic of the geometric relationship between the two bases and can be used strategically to create alternate creasing patterns.



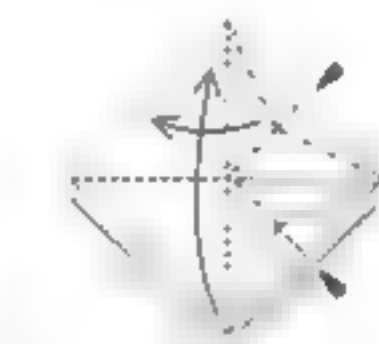
If one were to approach a single flap of either of these bases as a separate piece of paper, then it stands to reason that the same double and quadruple rabbit ear configurations that we discovered in the frog and bird bases could also be applied to each flap of these bases. Consider the relationship between the preliminary and frog base. To create a frog base one executes a double rabbit ear, a squash fold, followed by a petal fold on each of the flaps of a preliminary base. If the double rabbit ear can be executed on a preliminary base, then logically the same procedure could be executed on a waterbomb base, by taking each flap, squash folding, and petal folding the result. Doing this leads to a completely different structure from the frog base, with an identical creasing pattern. This is because the two forms are geometric variations of each other, like the preliminary and waterbomb bases. In fact, you can move from one form to the other by reversing the direction of each of the eight points in either form. In the illustration below, the difference between the two forms is shown with regard to the focus of the double rabbit ear, either on the pointed flap or the square flap.



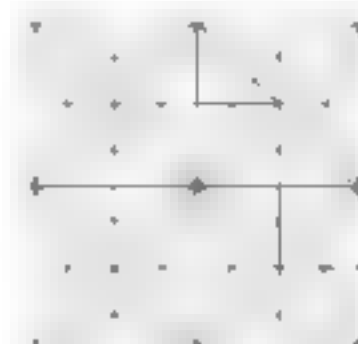
The same thing can be also be done on each base utilizing quadruple rabbit ears. Folding a quadruple rabbit ear on a flap of a waterbomb base is straightforward, and results in a structure very similar to a buntz frog base, which is not surprising because after executing four quadruple rabbit ears on a single sheet of paper, each of the four flaps of the base, one would expect a structure containing 16 rabbit ears, which is exactly what the buntz frog base contains. On the other hand, executing a quadruple rabbit ear on a single flap of a preliminary base is not as intuitive, though it can be done. It is analogous to the procedure used for the waterbomb base, except that each rabbit ear is reversed. If you are interested, try to figure it out on your own, using the illustration below as a guide. But be careful, it is much easier to execute 8 rabbit ears as you told than it is to execute 4. What is important is that the creasing patterns for all three of these forms are identical.



Quadruple rabbit ear being executed on one flap of a waterbomb base



Quadruple rabbit ear being executed on one flap of a preliminary base

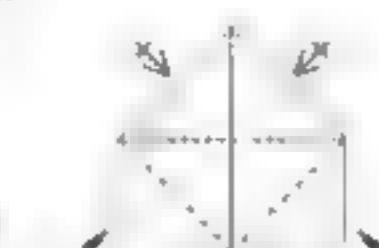


Resultant creasing pattern of the buntz frog base

Next, examine the relationship between the preliminary base and the bird base. If one executes a petal fold on both sides of a preliminary base, a bird base results. It stands to reason that the same thing could be done to a waterbomb base. Doing so, excepting the petal fold and following it with two reverse folds, results in an interesting structure. It consists of four waterbomb bases which are bound together at the center and then flattened inside out, it transforms into a windmill base. This makes sense, considering that the windmill base contains four preliminary bases and the fact that the waterbomb and preliminary bases are geometric inversions of each other.



Petal fold being executed on a waterbomb base

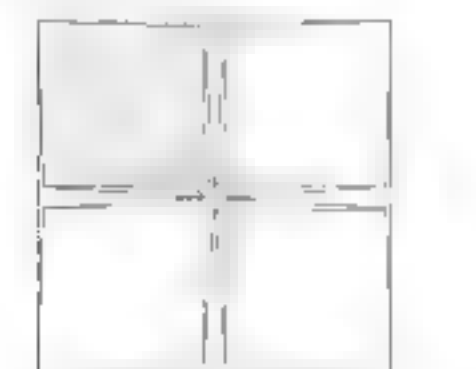


Followed by two reverse folds

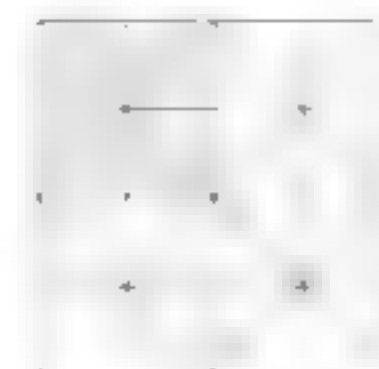


Result of a petal fold followed by two reverse folds. The resulting windmill base with a single waterbomb base shown in gray.

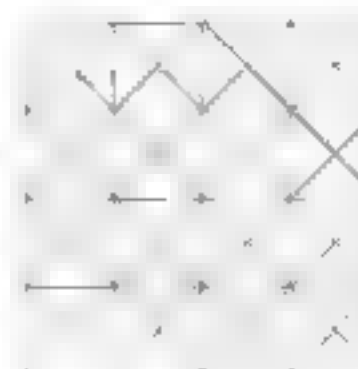
Notice also the creasing pattern of the windmill base. In a similar fashion to the waterbomb and preliminary bases, the paper is broken up into 16 separate square regions. This occurrence of 16 squares can be used to our advantage to progress to more complex forms by applying the double and quadruple rabbit ear technique.



Standard windmill base with the same area shown in gray



Creasing pattern of both forms



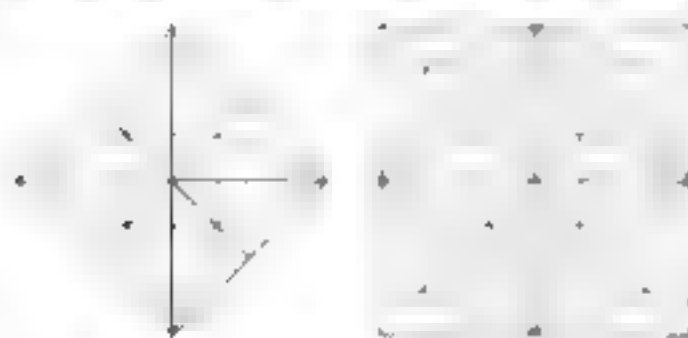
Creasing pattern of the buntz windmill base

In the creasing patterns of each of the blintzed versions of the traditional bases, the number of modules and rabbit ears for the standard base can be seen to be doubled. This is because in each case the standard creasing pattern for the base is reflected through the edge of the paper. In the simpler cases this leads to variations of the patterns of other bases, but in the more complex cases deeper levels of the progression found when studying the relationships between the fish, bird and frog bases are to be discovered. In the example below, a standard waterbomb base is shown reflected through the edge of the paper as well as the creasing patterns of the blintz fish, blintz bird and blintz frog bases. Notice that the creasing pattern of the blintz frog base is a variation of the bird base and that the creasing pattern of the blintz bird base is a variation of the frog base. In each case, the blintz version has a creasing pattern which is a variation of the standard base which is one level above it.

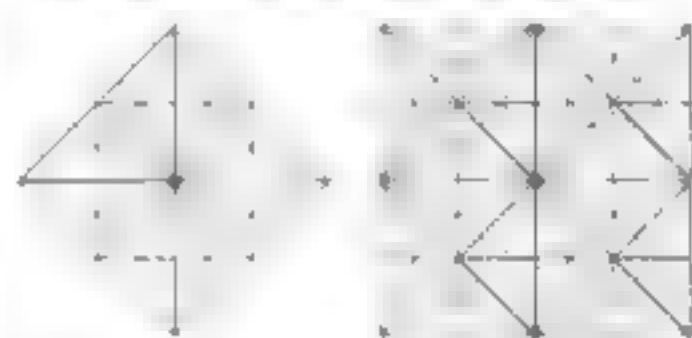


Creasing patterns of standard and blintzed waterbomb bases

Creasing patterns of standard and blintzed bird bases

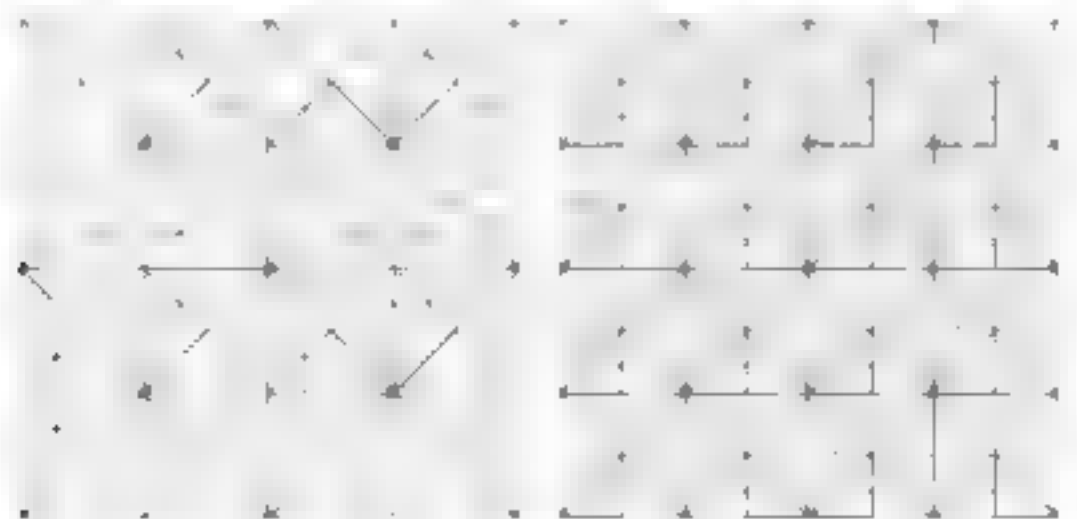


Creasing patterns of standard and blintzed frog bases



Creasing patterns of standard and blintzed frog bases

Finally, utilizing the reflective relationship found in the blintz windmill base and the double-ended triple rabbit ear approach, which we previously applied to the waterbomb and primary bases, the next two logical steps in the original progression can be found. They are found by taking a blintz windmill base, folding it into a structure similar to an eight flapped waterbomb base, and executing four or quadruple rabbit ears on each of the flaps, resulting in bases which contain 32 and 64 rabbit ears respectively. This technique was used to create the base that was used in the "Crown Fish & Sea Anemone" model. If you are intrigued by these relationships, I encourage you to continue experimenting on your own. Logically deeper levels of the pattern exist. I only remains for their folding method to be discovered.

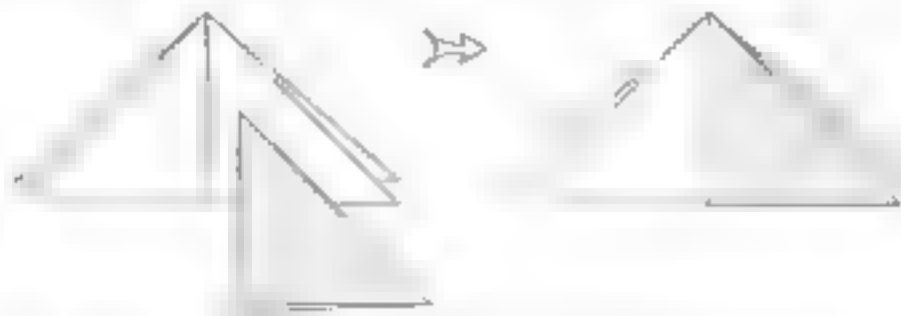


Standard and blintzed bases with 32 rabbit ears

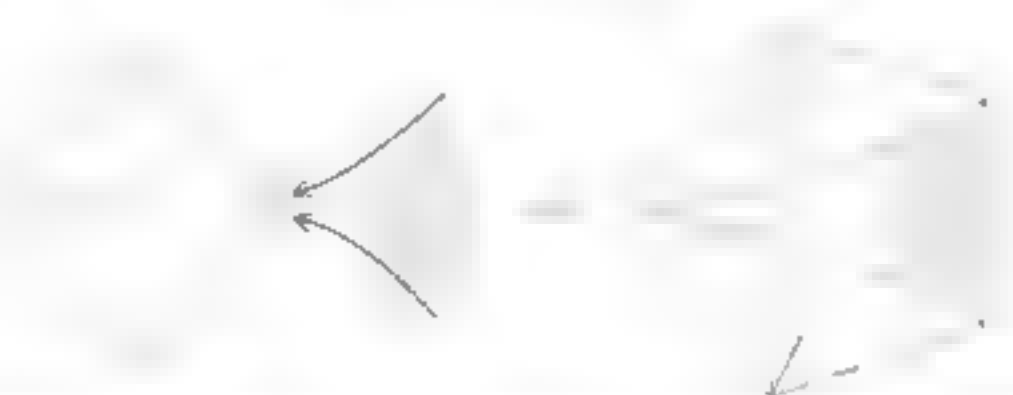
Standard and blintzed bases with 64 rabbit ears

## Multiflapped Waterbomb and Preliminary Bases

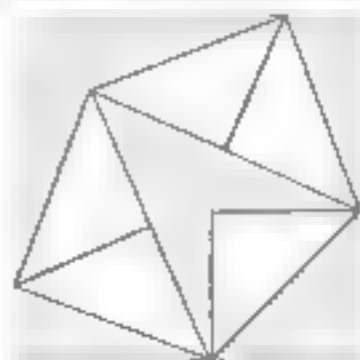
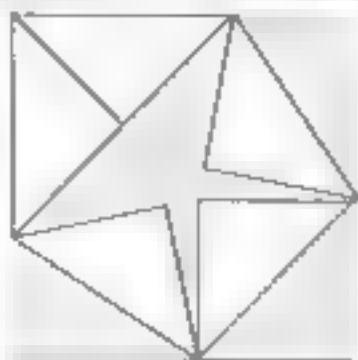
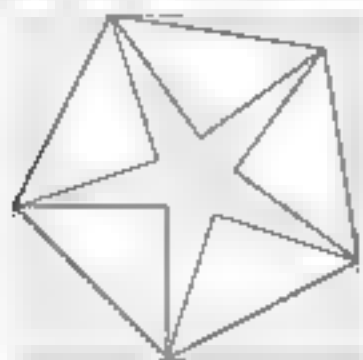
In creating a multiflapped waterbomb base, one must first consider the structure of a standard waterbomb base, consisting of four identical flaps, each of which takes up one-fourth of the paper. If you were to split the paper between two of the flaps and insert another flap (a square one-fourth the size of the original piece of paper) the result would be a five flapped waterbomb base.



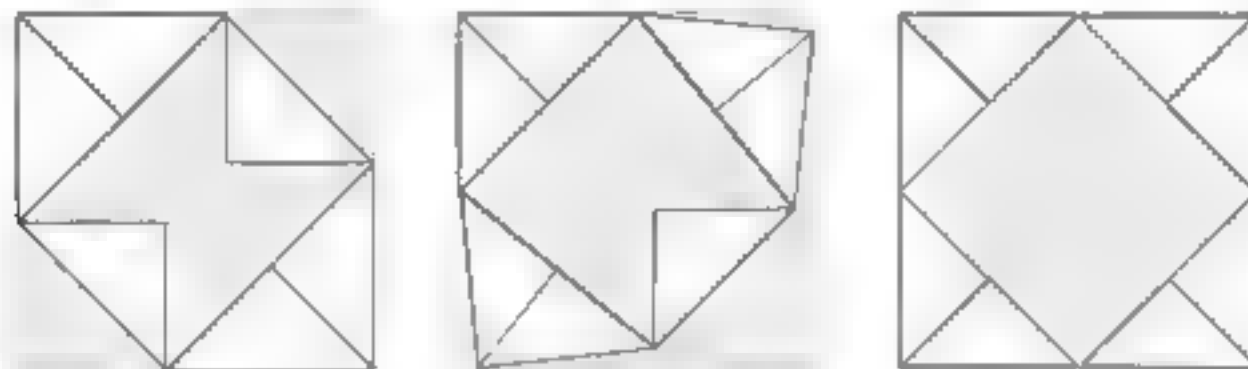
But if you try to "unfold" the structure, you will discover that it is impossible and it will not lie flat on the table. Geometrically, this is because in the standard waterbomb base each of the triangles that make up the base is a right triangle, with its 90 degree angle at the center of the paper. With four triangles in this case, there is a total of 4 times 90, or 360 degrees in the center of the paper, which makes a full rotation around the center. To add another triangle, one of two things must happen: either the mode must become three-dimensional, or the square must open up into a pentagon, and some extra area must be added to the center to allow the 90 degree angle of each triangle to change to a more narrow angle of  $72$  degrees ( $1/5$  of 360).



To fold a five-sided base from a single square of paper, one must then superimpose the resulting pentagonal shape (shown above) on a flat piece of paper, and strategically fold to eliminate the extra area in the center and on the edges. The illustration below shows in gray the areas which must be removed. The most important aspect of the pattern is not the angles between the white shapes, but the fact that they are linked at the corners. By rearranging the configuration of the shapes, cleaner bases can be developed. For example, if you were to fold from the first diagram, eliminating the five-pointed star would generate a base where the top edge of each flap would have two parallel edges connected by a depressed region of paper, rather than the single unbroken ridge which occurs on each flap of the standard waterbomb base. But one were to change the angles between the triangles and work from the second figure, one would be able to create a base which has the indentation on only three of the five flaps, though the resulting base would be slightly larger than the first. Working from the third form, on the other hand, produces a base wherein only two of the flaps contain indentations and which is slightly smaller than the others.



The same procedure can be used to create six, seven and eight flapped bases. It turns out that the six and eight flapped bases are easiest to produce because of their geometric simplicity. The eight sided base is particularly interesting because it is folded from a standard waterbomb base which means that the algorithm used to create the eight sided base can be applied to other multi-flapped waterbomb bases to create bases with twice the number of flaps as the original base. I've used this approach to create ten and sixteen flapped bases from waterbomb bases with five and eight flaps. The procedure can be applied additional times to create bases with even higher numbers of flaps such as twenty or thirty two. Unfortunately each additional time the procedure is applied the total amount of paper being folded grows which creates a thicker model and increasingly complex internal encumbrances must be dealt with.

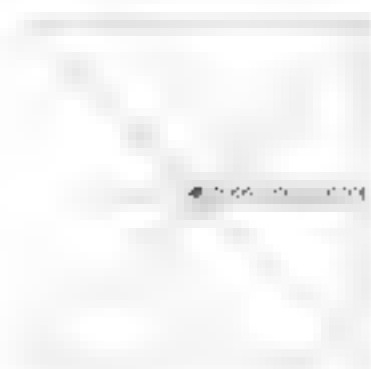


## Cheater Bases

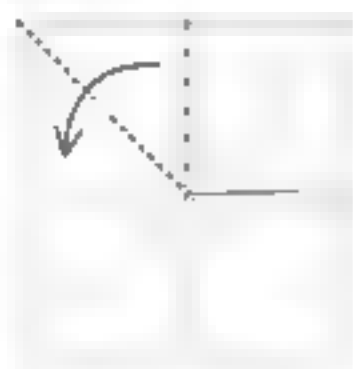
Each of the multi-flapped bases can also be created by simply constructing the additional flaps and bonding them into a standard four flapped base with cellophane tape. For the purposes of bonding paper together you will want the most resistant material possible. It is best to use inexpensive tape because more expensive tapes tend to tear easily and in many cases have glue which is too tacky making it easier to remove. Always fold in the side which will not be exposed, and be extremely careful when lining up the sides of the paper. Working with a poorly aligned cheater is as difficult as folding from a piece of paper which is not a true square.

I strongly recommend using cheaters when initially folding the difficult models in this book, as well as when you are experimenting with a design. Using cheaters allows you to deal with the fundamental structure of the base without having to worry about additional internal encumbrances or depressed edges. After the model has been mastered or the design process has been completed, you can go back and recreate the piece with the folded version. This approach is radical, but it means the difference between success and failure, by all means succeed!

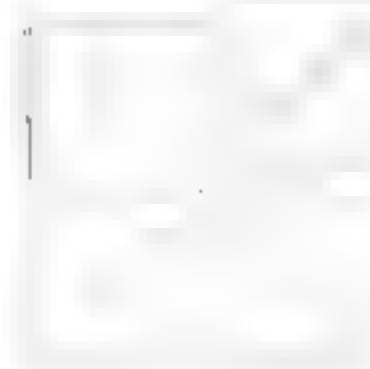
### Five Sided Cheater Base



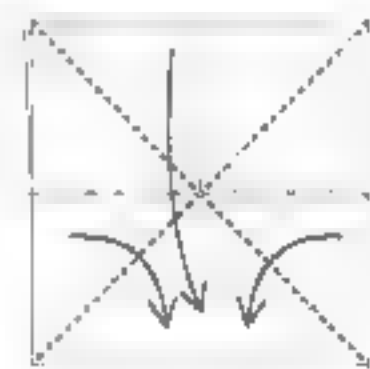
1. Start with a square of paper precreased to fold a waterbomb base. Carefully cut halfway along one horizontal



2. Fold one flap out of the way

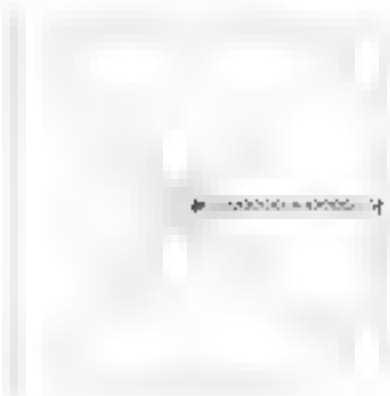


3. Take another square of paper exactly 1/4 the size of the original square and precreased as shown and carefully tape it into place

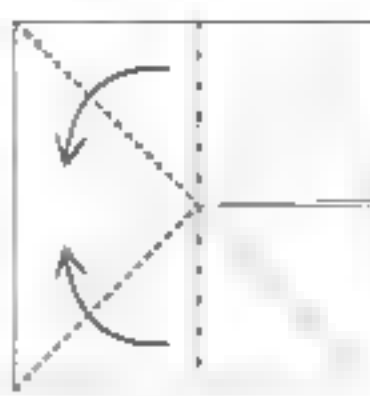


4. To complete the base, fold it up as with a regular waterbomb base. To make a preliminary base turn the waterbomb base inside out

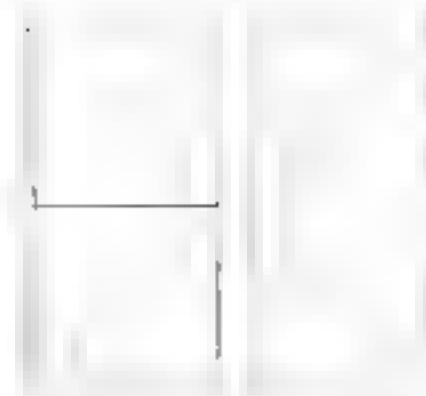
## Six Sided Cheater Base



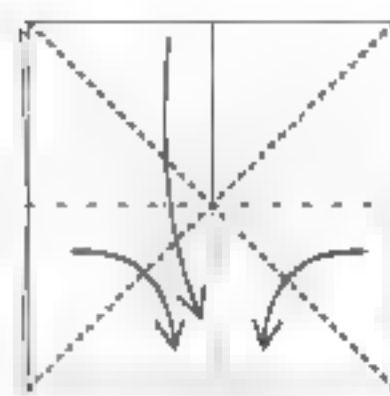
1 Start with a square of paper precreased to fold a waterbomb base. Carefully cut half the length of the horizontal



2 Fold two flaps out of the way

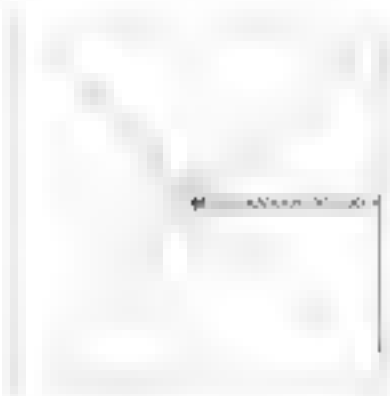


3. Take another piece of paper, exactly 1/2 the size of the original square and precreased as shown and carefully tape it into place.

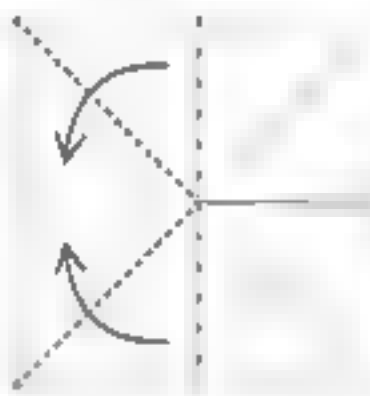


4. To complete the base, fold it up just as with a regular water bomb base. To make a preliminary base, turn the waterbomb base inside out.

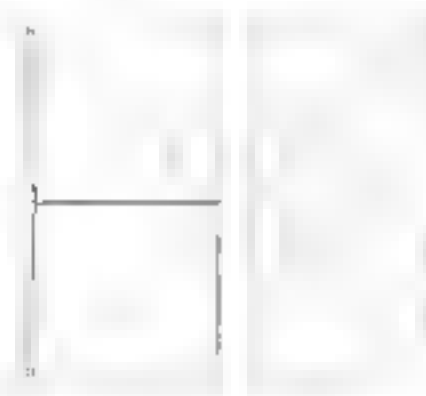
## Seven Sided Cheater Base



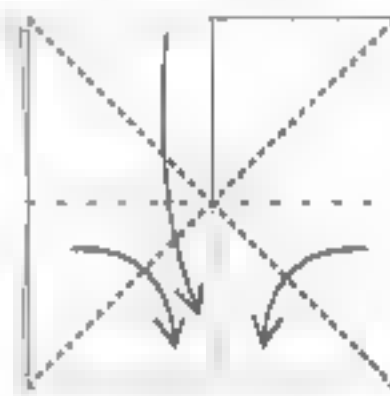
1. Start with a square of paper precreased to fold a waterbomb base. Carefully cut halfway along one horizontal



2. Fold two flaps out of the way.

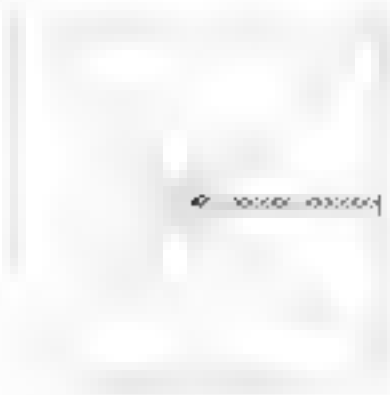


3. Take another piece of paper, the same size as the original square with one fourth cut away and folded into a rectangle and carefully tape it into place.

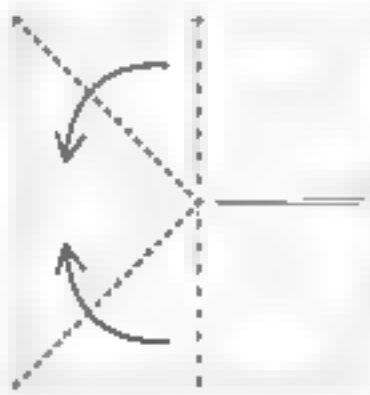


4. To complete the base, fold it up just as with a regular water bomb base. To make a preliminary base, turn the waterbomb base inside out.

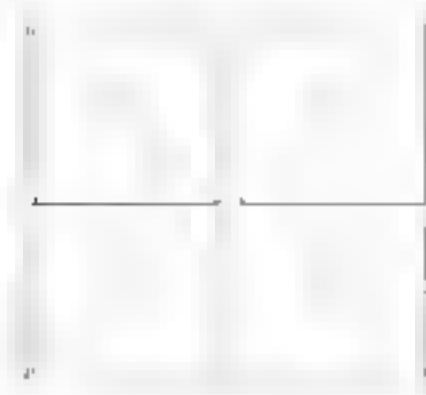
## Eight Sided Cheater Base



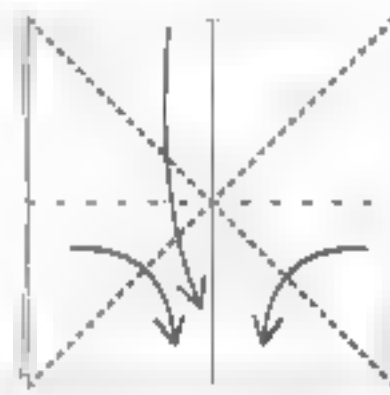
1 Start with two squares of paper precreased to fold a waterbomb base. Carefully cut both halfway along one horizontal



2. Fold two flaps out of the way on both pieces of paper

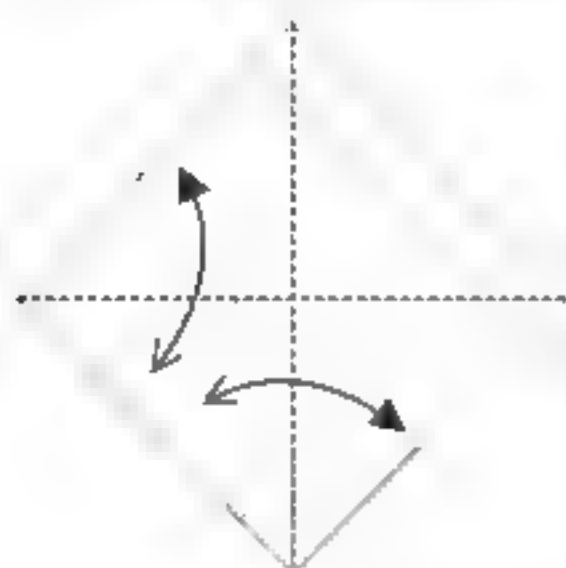


3. Take both pieces of paper and carefully tape them together

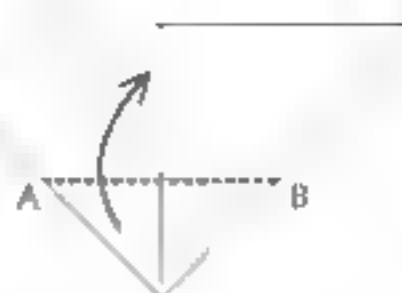


4. To complete the base, fold it up just as with a regular water bomb base. To make a preliminary base, turn the waterbomb base inside out.

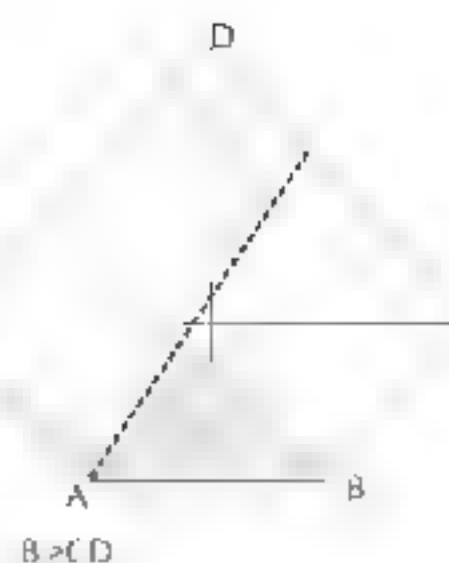
## Five Flapped Folded Base



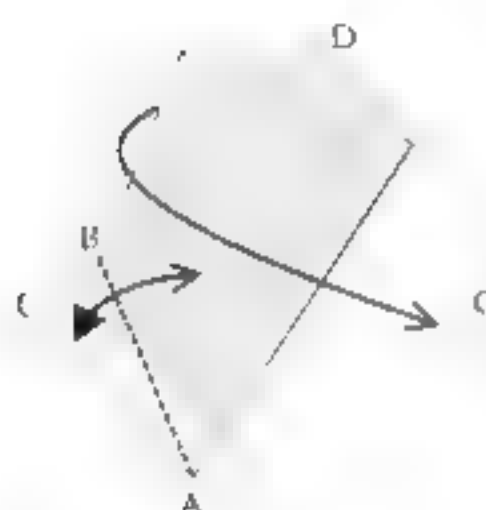
1. Crease diagonally and unfold



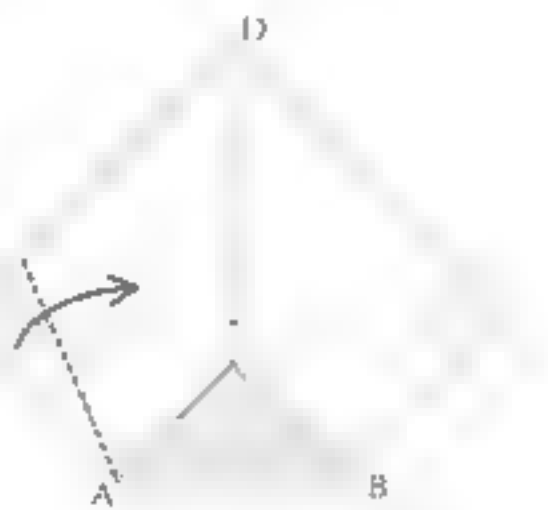
2. Fold upward to form AB. The exact distance is  $\frac{1}{4}$  of the distance from the bottom to the center



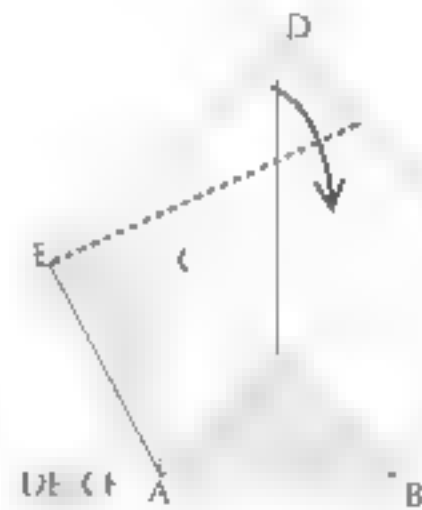
3. Bring point B up to edge CD, crease lightly



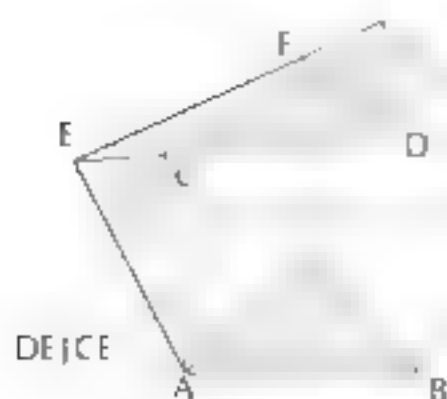
4. Create AB and unfold, don't forget step 3



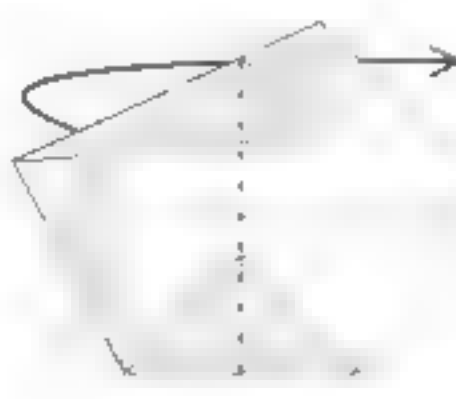
5. Fold the segment creased in step 4 back in place



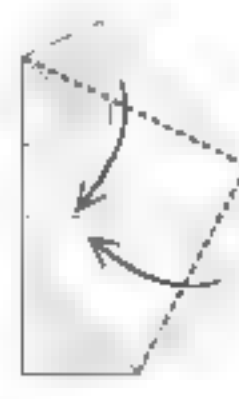
6. Fold flap so that DF is parallel to CE



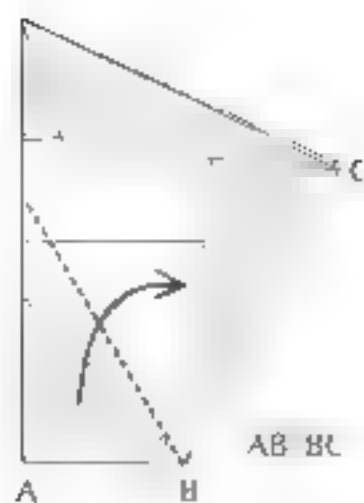
7. Angle AEF should be a perfect 90 degree angle  
AB should exactly equal AE and AE should exactly equal EF  
if  $AE = EF$  then proportions are right, proceed  
if  $AE > EF$  then AB is too high, start over with step 2  
if  $AE < EF$  then AB is too low, start over with step 2



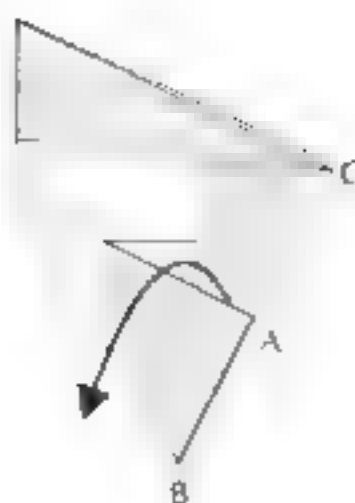
8. Carefully fold the model in half along the center crease



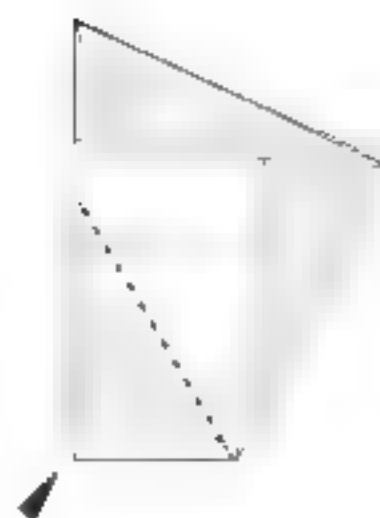
9. Very carefully crease the flaps, precisely matching the folds already on.



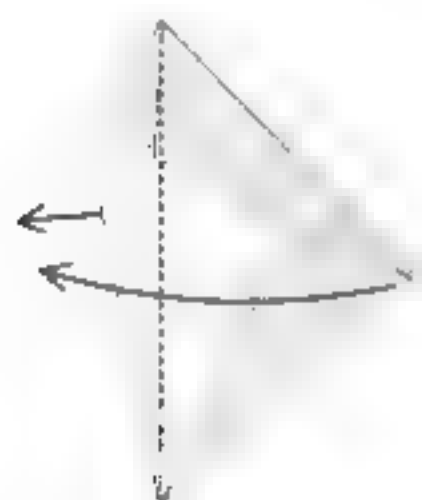
10. Carefully fold the flap upward so that AB is parallel to BC.



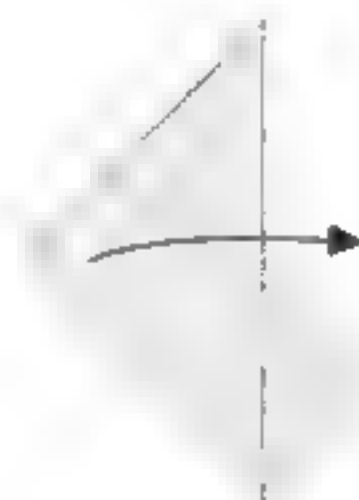
11. Unfold the flap.



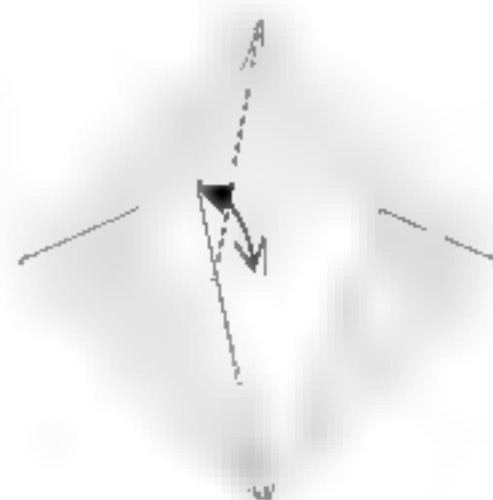
12. Reverse fold the flap.



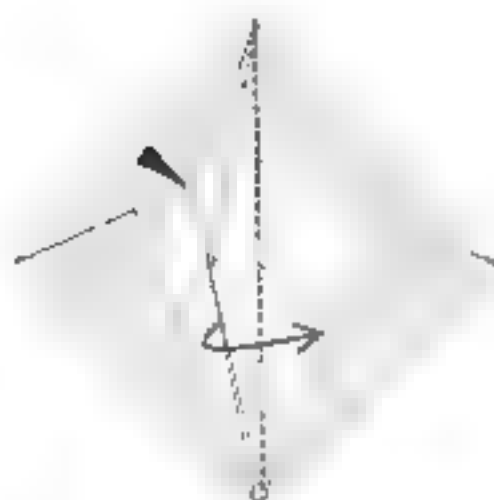
13. Fold the front and back flaps to the left.



14. Fold the front flap back to the right.



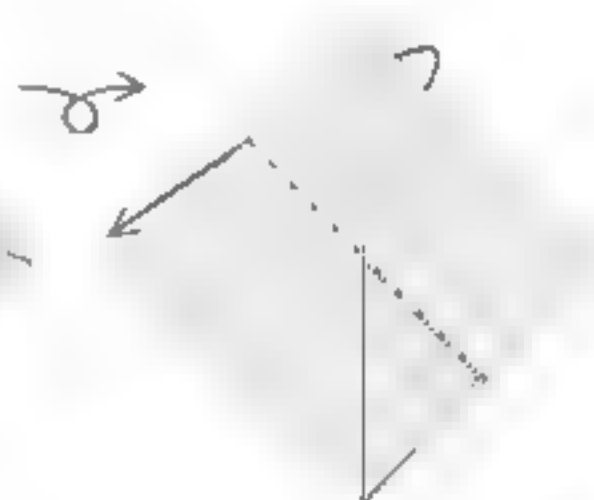
15. Fold a side flap down.



16. Put a single layer to the right, while spread sinking the triangular area at the top.

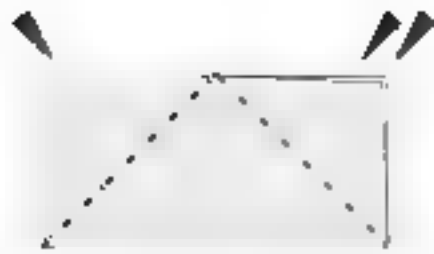


17. Completed module for one flapped base. Turn the module over.



18. Mountain fold the module in half.



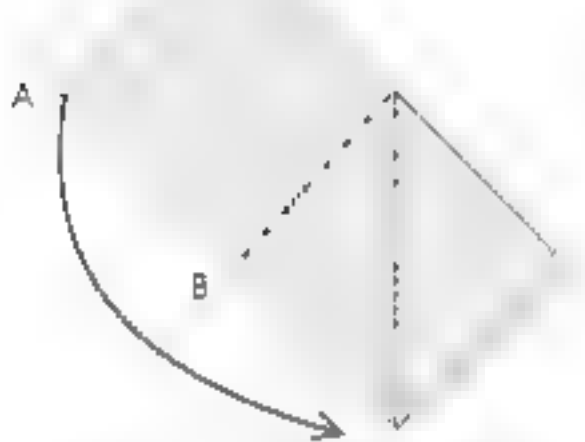


#### FIVE FLAPPED WATERBOMB BASE

1. Start with the result of step 18. Reverse fold the three flaps, being extremely careful to keep the inside layers flat, as if there were one, continuous surface inside.

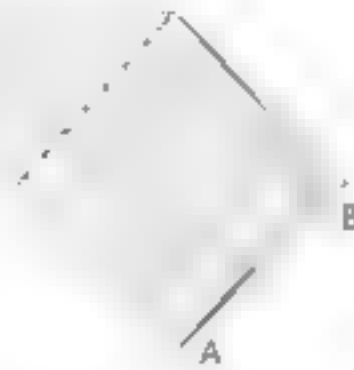


2. Completed five flapped waterbomb base.

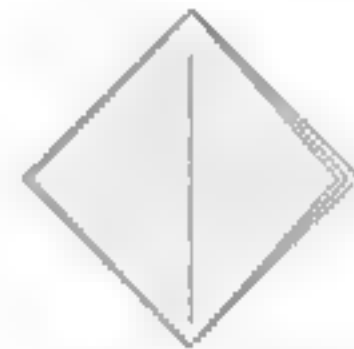


#### FIVE FLAPPED PRELIMINARY BASE

1. Start with the result of step 18. Squash fold the large flap, being extremely careful to keep the inside layers flat, as if there were one, continuous surface inside.

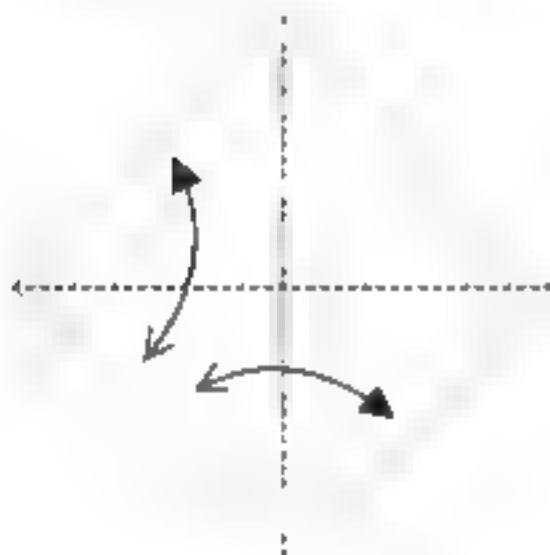


2. To complete the base, reverse fold the flap, being very careful to keep inner layers flat.



3. Completed preliminary base. To create a five flapped bird base, petal fold each of the flaps, as with a regular bird base.

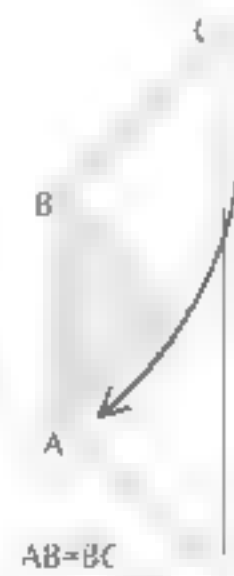
### Six Flapped Folded Base



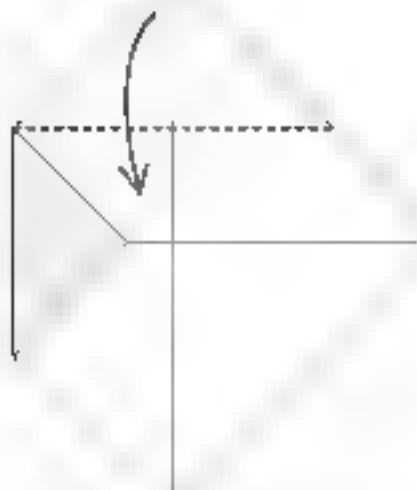
1. Crease diagonally and unfold.



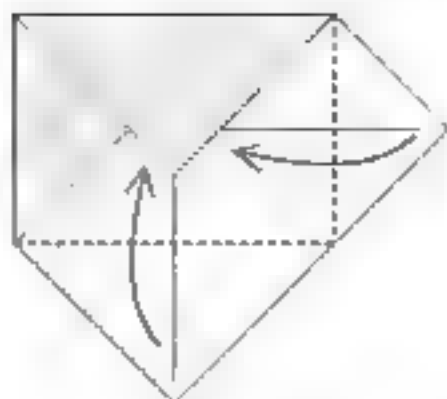
2. Crease diagonally and unfold. The exact distance is 41 of the distance from the corner to the center.



3. Fold point C to point A. Do not crease! The length of segment AB should be exactly the same as BC. If AB is shorter than BC, then refold AB so that it is longer; otherwise, refold AB so that it is shorter.



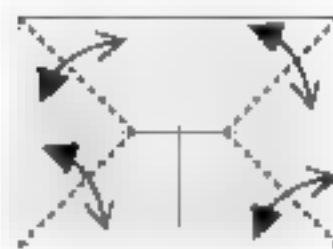
4. Carefully turn the flap down.



5. Fold the remaining two flaps into place.



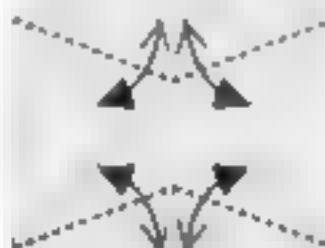
6. Turn the model over



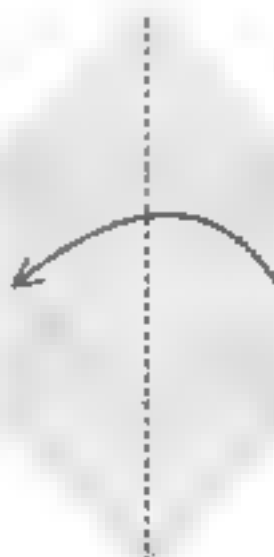
7. Crease diagonally and an old



8. Pull the flaps out from behind.



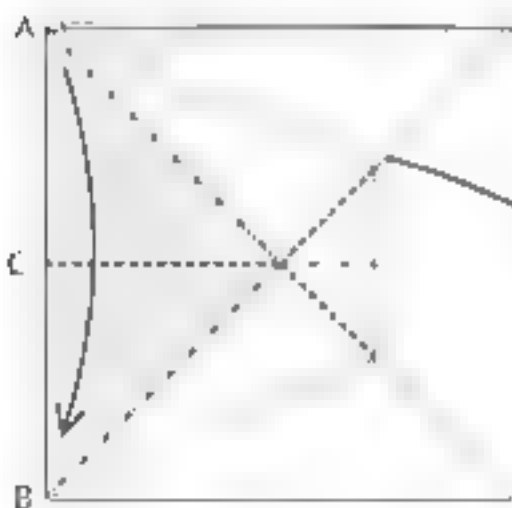
9. Crease where indicated



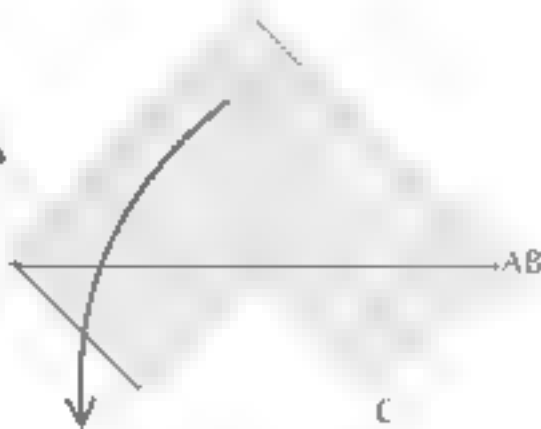
10. Fold the model in half.



11. Clamp twice on the creases



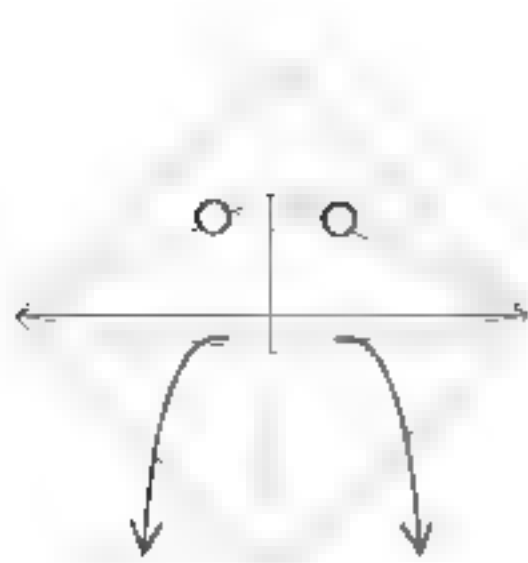
12. Pinch A to B. Point C will move away from you, repeat behind and the underlying layers will flip to the right. Don't worry about folds indicated by the lighter lines, they will follow naturally.



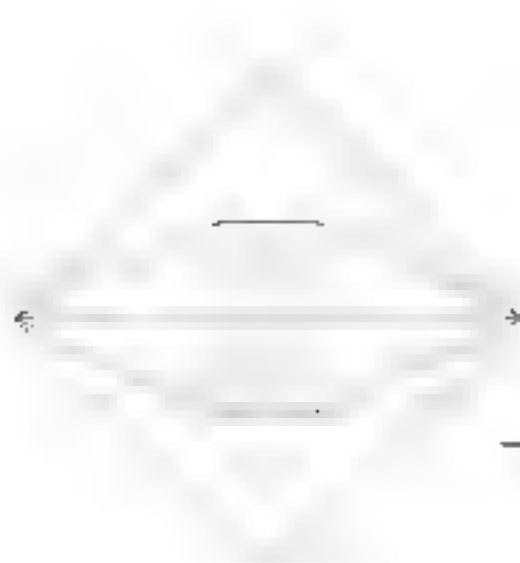
13. Fold a single flap down



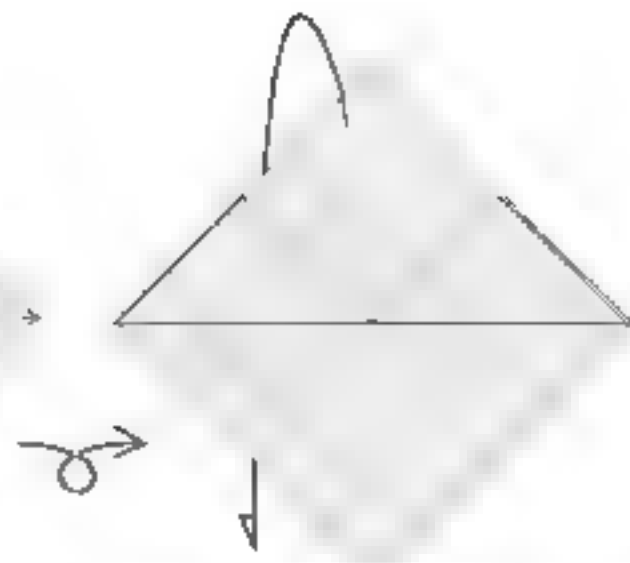
14. Fold single flap all the way down, anchoring where the circles indicate. As you do this a central ridge will appear. To complete the fold the ridge must be spread-squashed into a large rectangle.



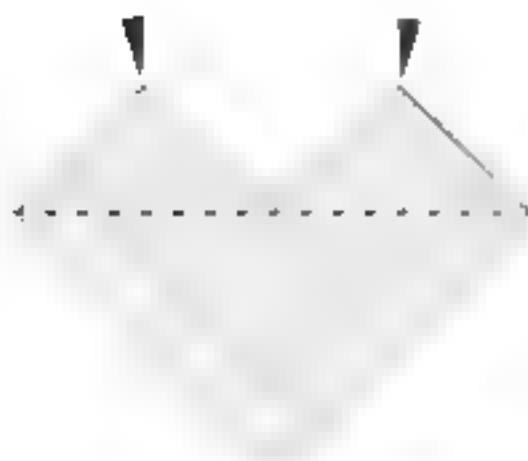
15 This is an intermediary view of the spread-squash.



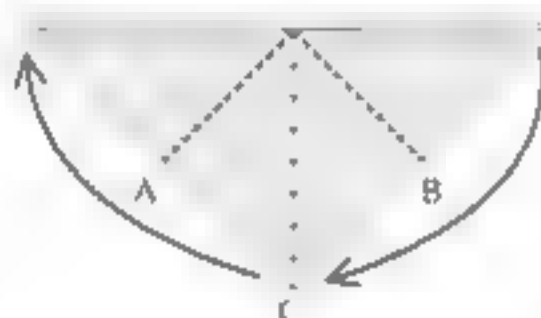
16 Completed module for six-sided bases. Turn the model over.



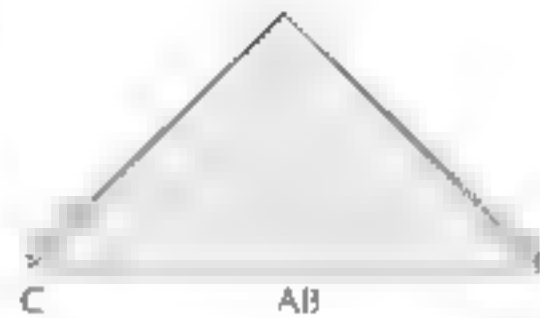
17 Mountain fold a single layer behind.



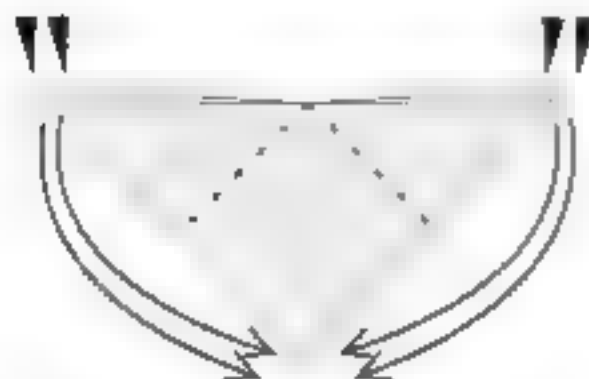
18 Reverse fold the two flaps.



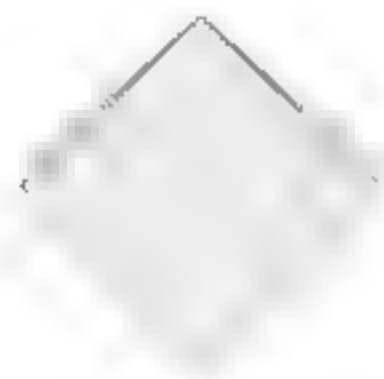
**SIX FLAPPED WATERBOMB BASE**  
1 Start with the results of step 18. Pinch each of the two side flaps together and squash fold the entire right side, bringing point B to A. Be extremely careful to keep the inside layers flat, as if they were one, continuous surface.



2. Completed six flapped waterbomb base.

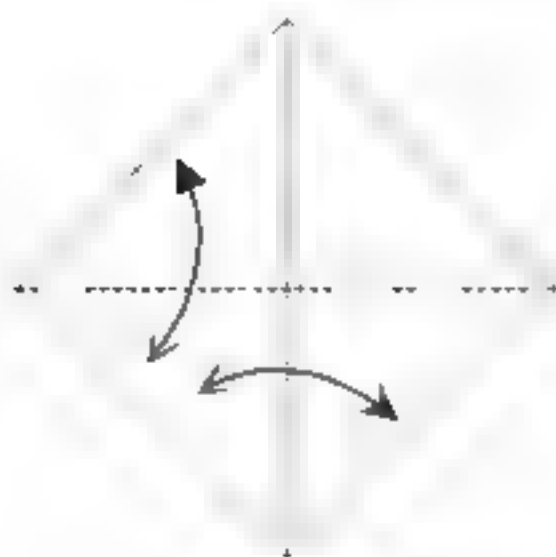


**SIX FLAPPED PRELIMINARY BASE**  
1. Start with the result of step 18. Reverse fold the four flaps, being extremely careful to keep the inside layers flat, as if they were one, continuous surface.

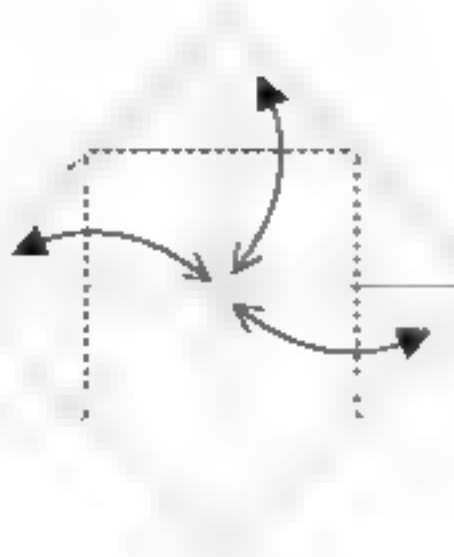


2 Completed preliminary base. To create a six flapped bird base, petal fold each of the flaps.

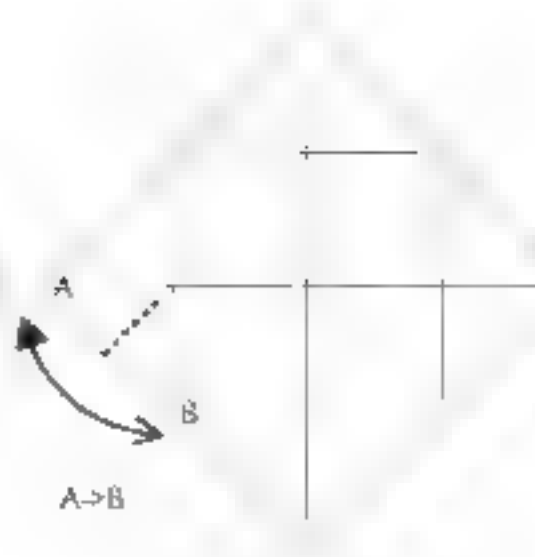
## Seven Flapped Folded Base



1. Crease diagonally and unfold.



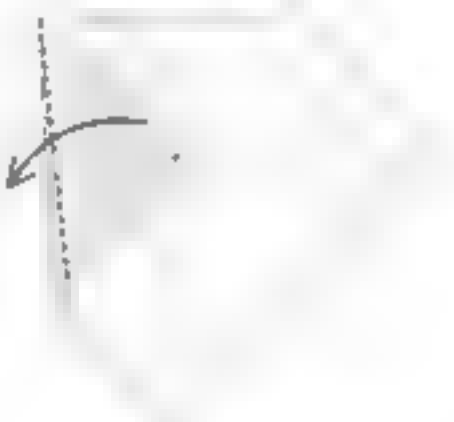
2. Crease and unfold.



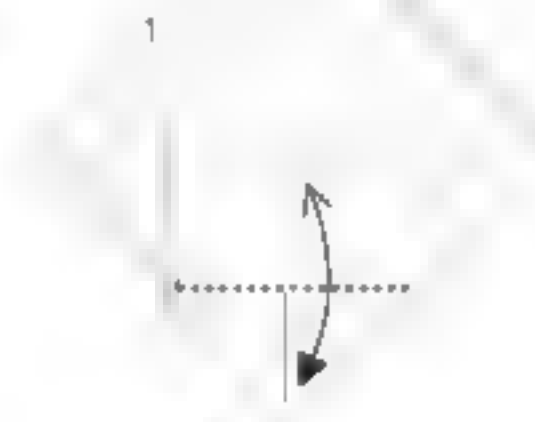
3. Fold A to B and unfold, creasing only the edge.



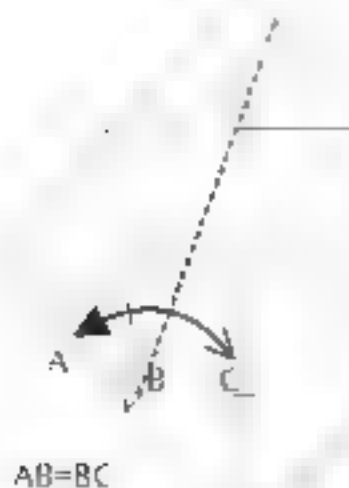
4. Fold the flap on the vector, slightly more than 45 (77.5) along the edge.



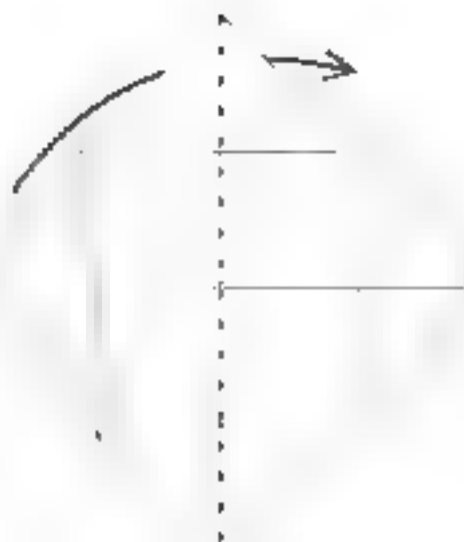
5. Fold the flap back on the crease made in step 2.



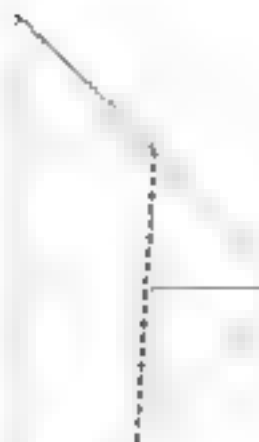
6. Fold and unfold, creasing lightly at the center.



7. Very carefully fold A to C swiveling at B. Do not crease! AB should equal exactly BC (A should meet the center line at C). If  $AB = BC$  go to the next step. If  $AB < BC$  then the angle is too small; go back to step 4 and try a larger angle. If  $AB > BC$  then the angle is too large; go back to step 4 and try a smaller angle.



8. Mountain fold the model in half



9. Fold the flap matching exactly the fold underneath



10. Fold the flap matching exactly the fold underneath



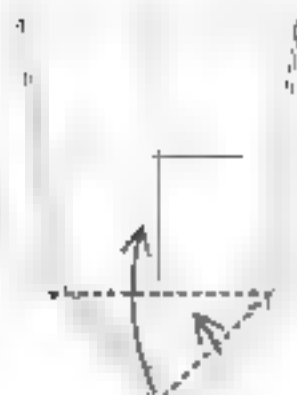
11. Unfold to step 8.



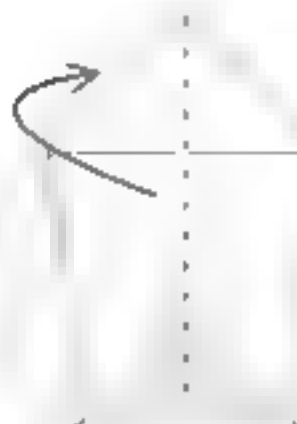
12. Carefully reverse fold the two flaps, assuring that the creases stay exactly in place.



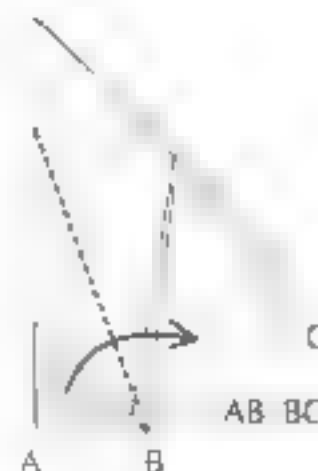
13. Fold the flap upward



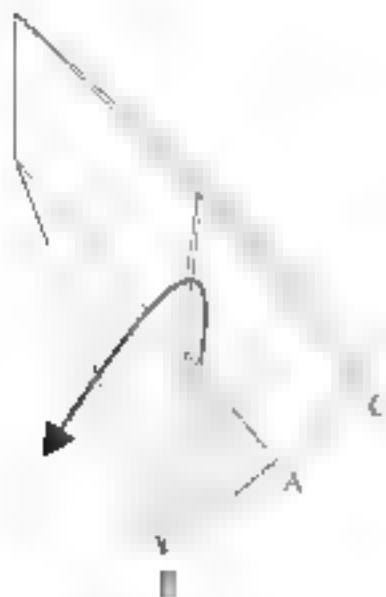
14. Fold the other side and then fold the entire flap upward



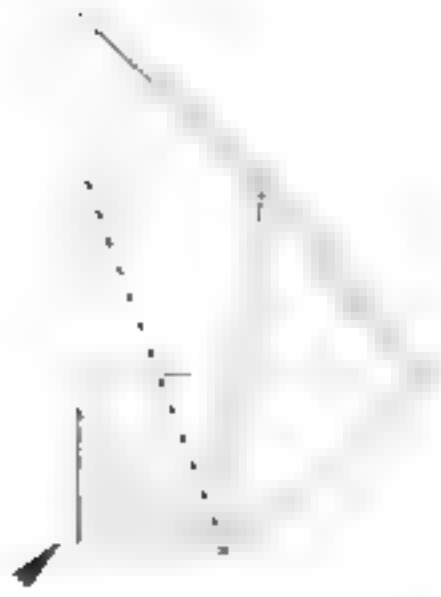
15. Fold the model in half backwards.



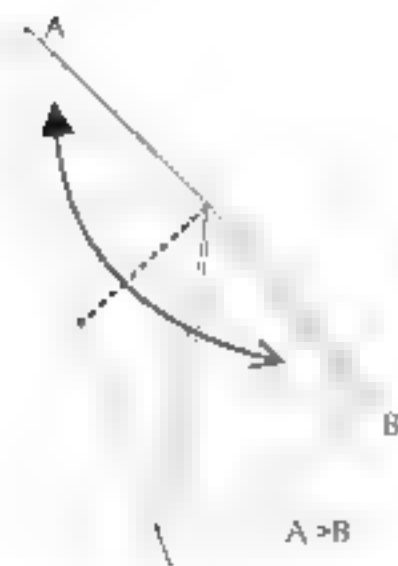
16. Fold the flap so that AB is parallel to BC



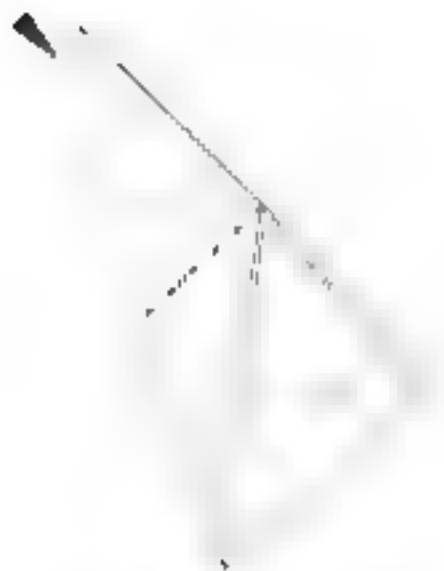
17 Note that the colored portion is parallel to one of the creases from the previous steps. Fold the flap back down.



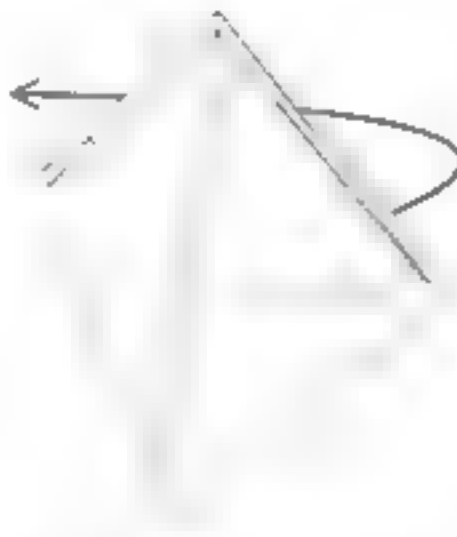
18 Reverse fold on the crease.



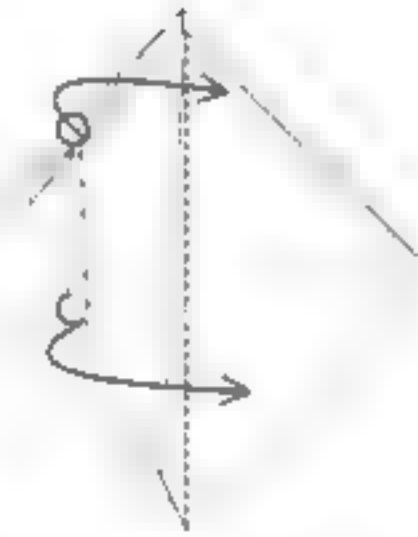
19 Fold point A to B and unfold.



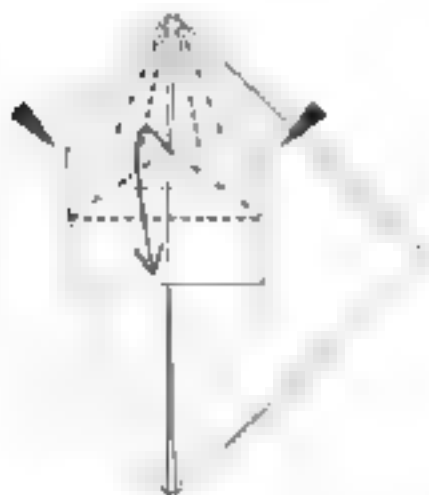
20 Reverse fold the flap. The upper part is a sink.



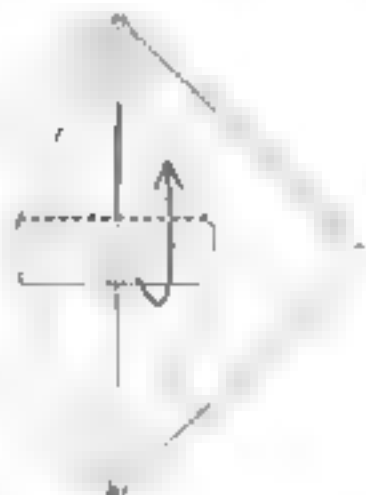
21 Fold one flap behind to the left.



22 Fold a single large flap all the way to the right, anchoring where indicated and allowing the trapped edge to spread-squash into a large, slightly trapezoidal region.



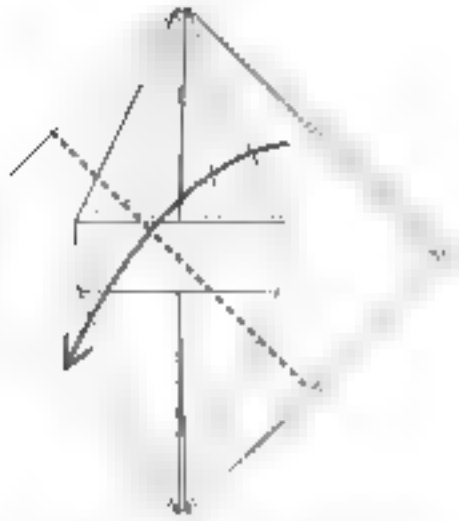
23 Petal fold, pulling the top of trapezoid all the way to its bottom. The sides will spread-squash naturally as you do this.



24 Fold the flap back up.

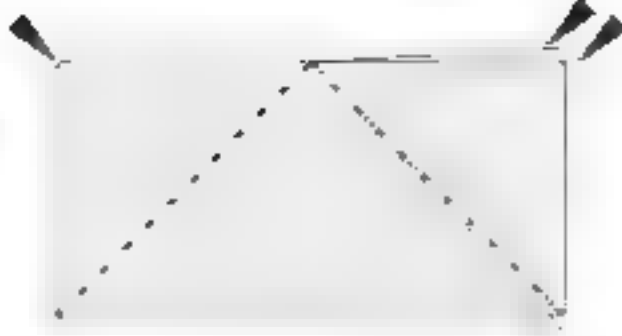


25 Sink the large flap inside.

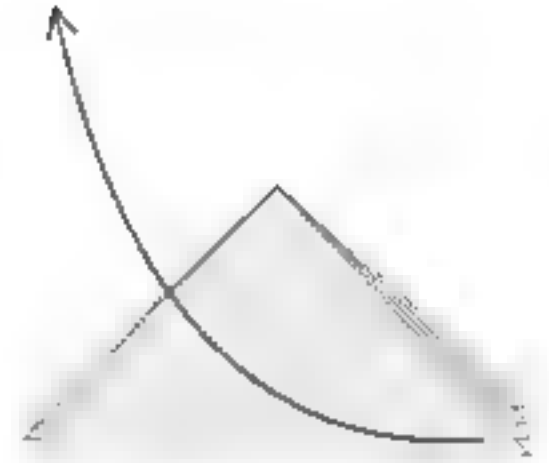


#### SEVEN FLAPPED WATERBOMB BASE

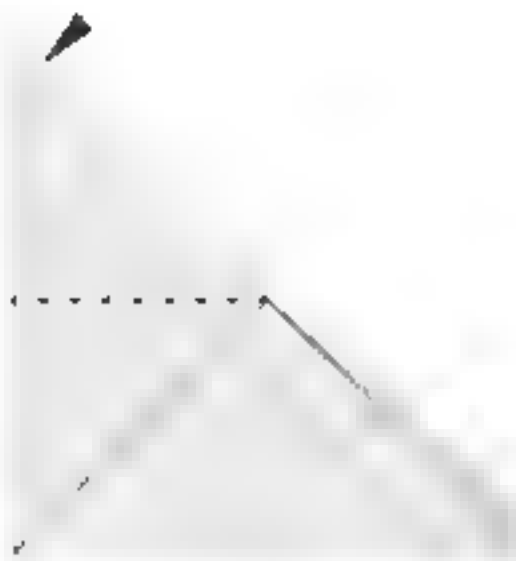
1. Start with the result of step 25.  
Fold the model in half



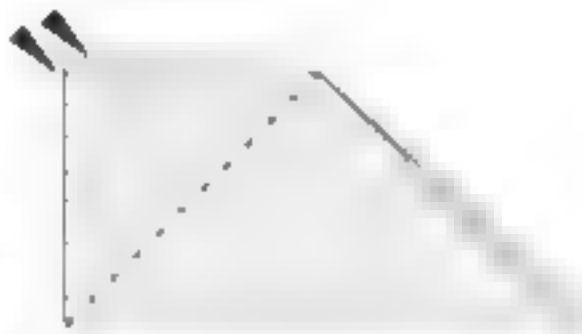
2. Reverse fold the three flaps being extremely careful to keep the inside layers flat as if they were on a continuous surface.



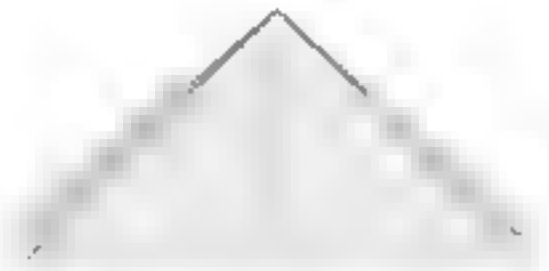
3. Fold the remaining flap up and to the left



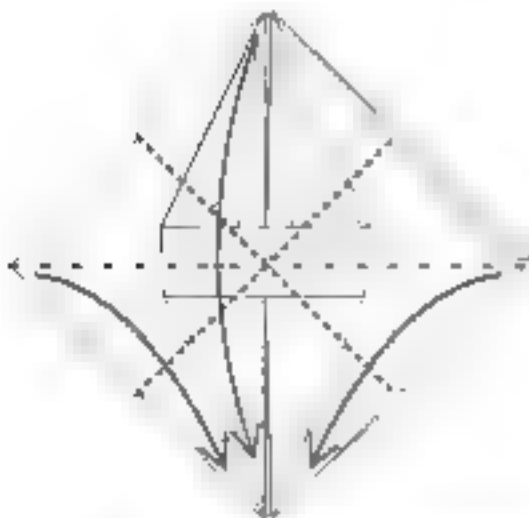
4. Reverse fold the flap



5. Execute two final reverse folds. Internal encumbrances will make these folds very difficult.

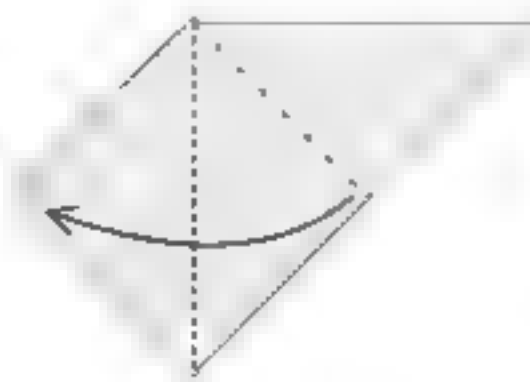


6. Completed seven flapped waterbomb base

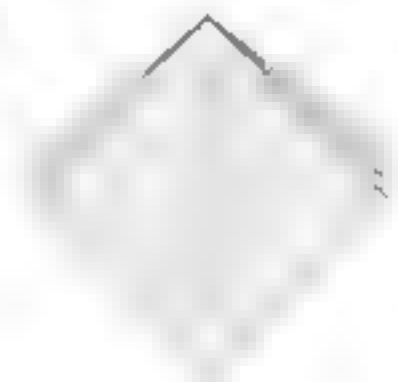


#### SEVEN FLAPPED PRELIMINARY BASE

1. Start with the result of step 25.  
Precrease and fold the model up as when folding a regular preliminary base.

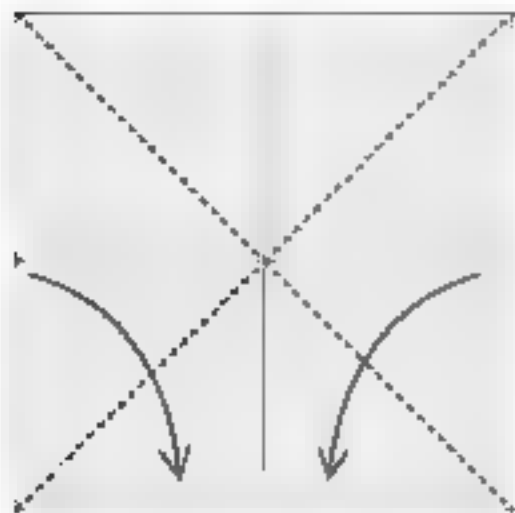


2. To complete the base, squash fold the last flap

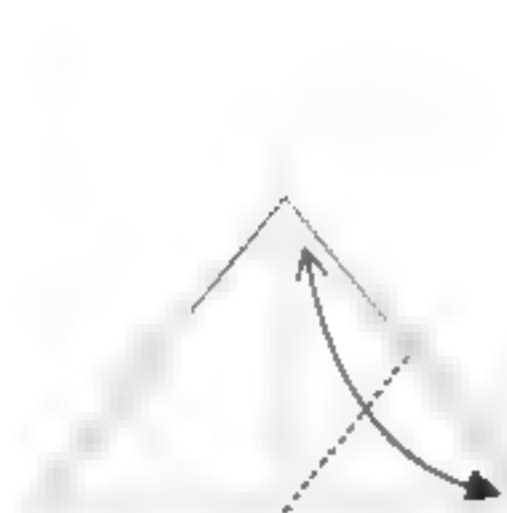


3. Completed preliminary base  
To create a seven flapped petal base, petal fold each of the flaps.

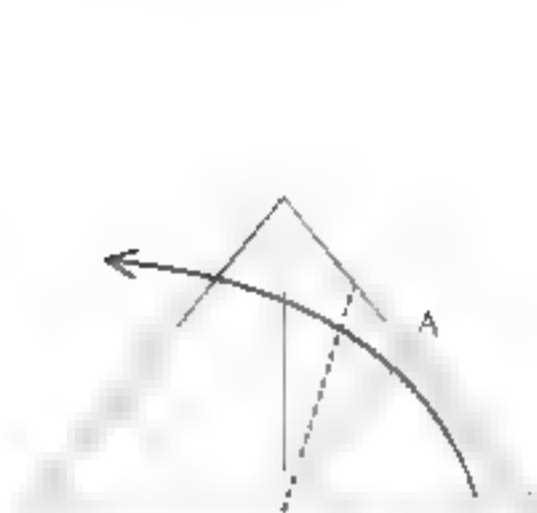
## Eight Flapped Folded Base



1. Start by creating a waterbomb base, white side out.



2. Fold and unfold the flap.



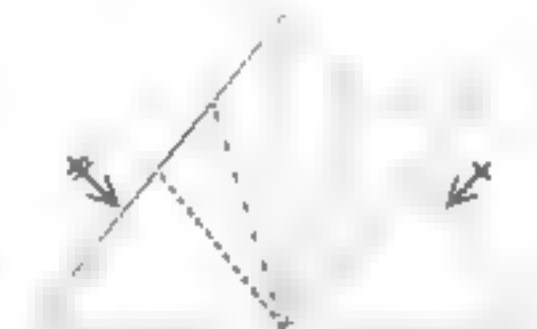
3. Fold the flap to the left, bringing point A to the center line.



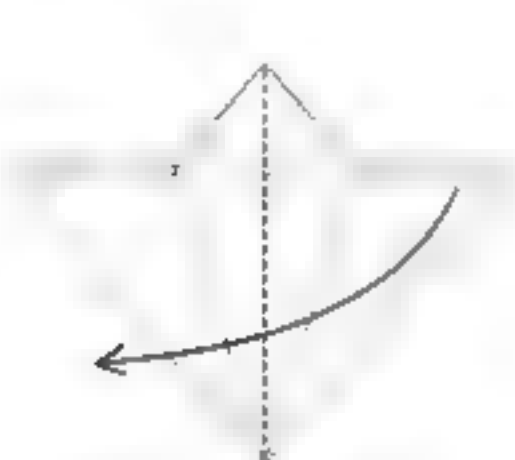
4. Fold the flap back to the right.



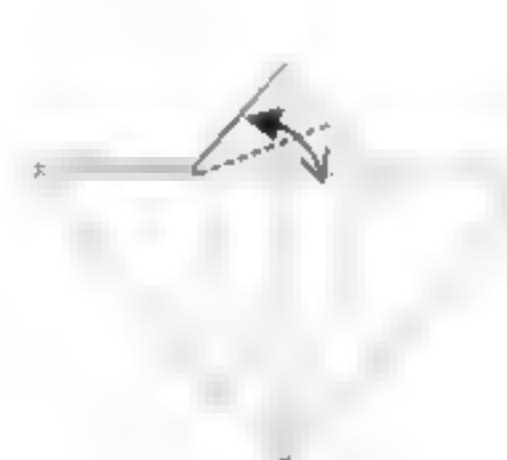
5. Crimp fold on the creases.



6. Repeat steps 2-5 on the other three flaps.



7. This is a buntz bird base. Fold one flap to the left.



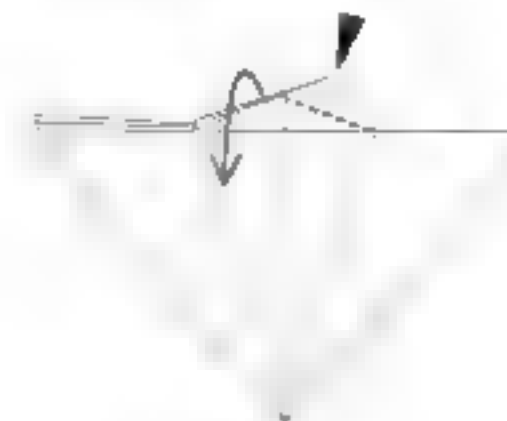
8. Fold and unfold.



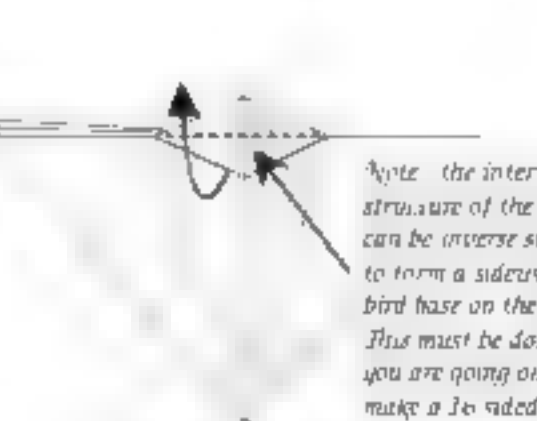
9. Sink the six sides in.



10. Fold and unfold.



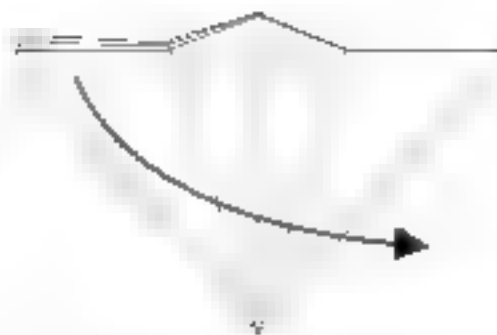
11. Fold two flaps down causing right side to spread-squash



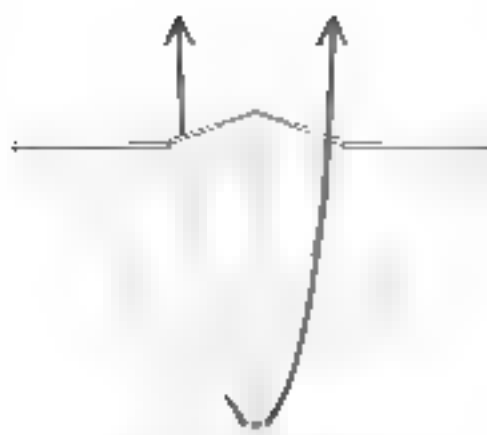
12. Fold the flaps back up

*Note: the internal structure of the sink can be inverse sunk to form a sideways bird base on the top. This must be done if you are going on to make a 16 sided base*

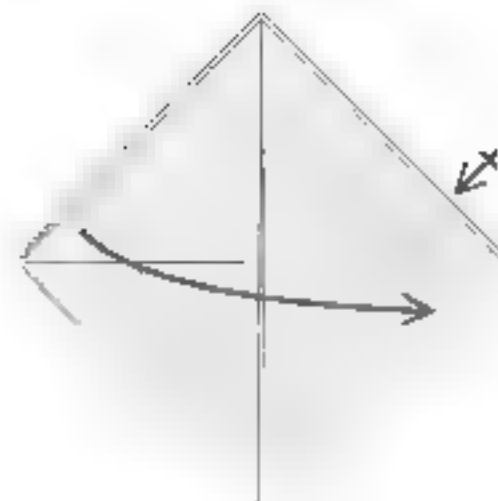




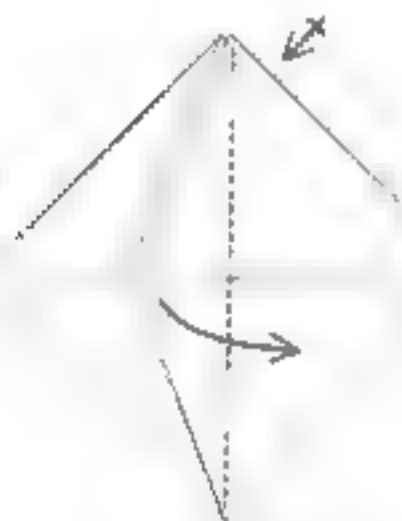
13. Fold the flap back to the right



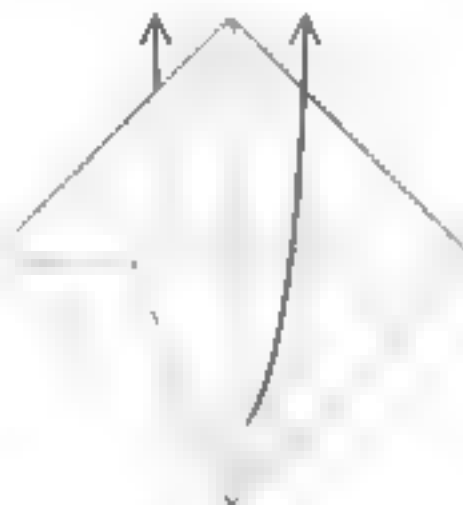
14. Fold one flap upward.  
Repeat behind.



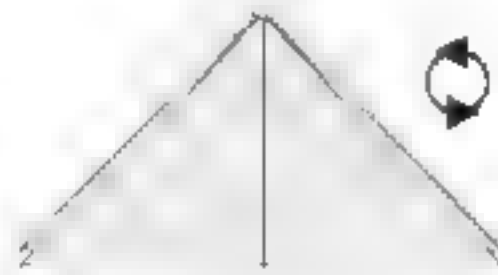
15. Fold one flap to the  
right. Repeat behind.



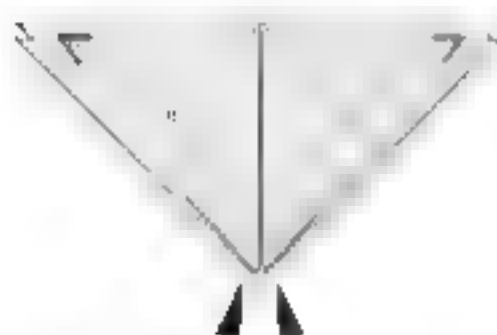
16. Fold one flap to the  
right. Repeat behind.



17. Fold one flap upward.  
Repeat behind.

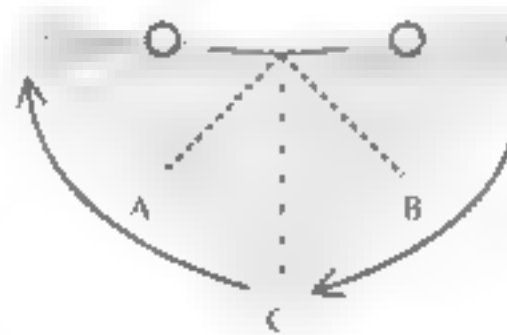


18. Completed module for eight  
flapped bases. Rotate 180 degrees

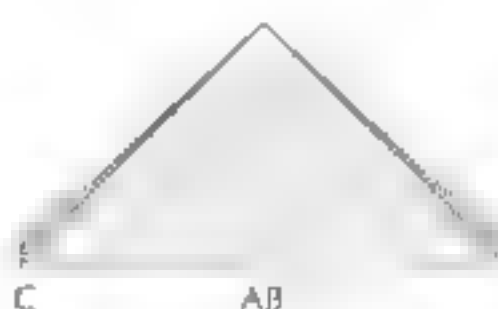


#### EIGHT FLAPPED WATERBOMB BASE

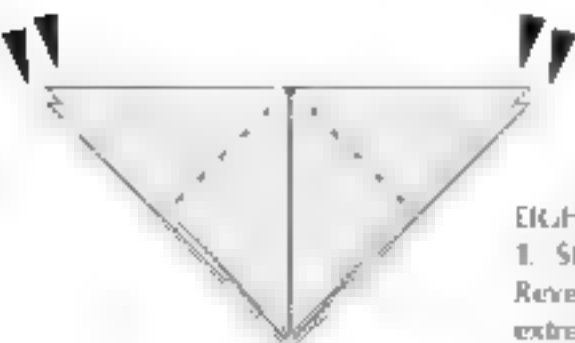
1. Start with the result of step 18.  
Reverse fold the two inside flaps up to  
the outer edges being extremely careful  
to keep the inside layers flat.



2. Pinch each of the three side flaps  
together and squash fold the right side  
as one flap while bringing point B to A.  
Be extremely careful to keep the inside  
layers flat.



3. Completed eight flapped  
waterbomb base



#### EIGHT FLAPPED PRELIMINARY BASE

1. Start with the result of step 18.  
Reverse fold the four flaps, being  
extremely careful to keep the inside  
layers flat, as if there were one  
continuous surface inside

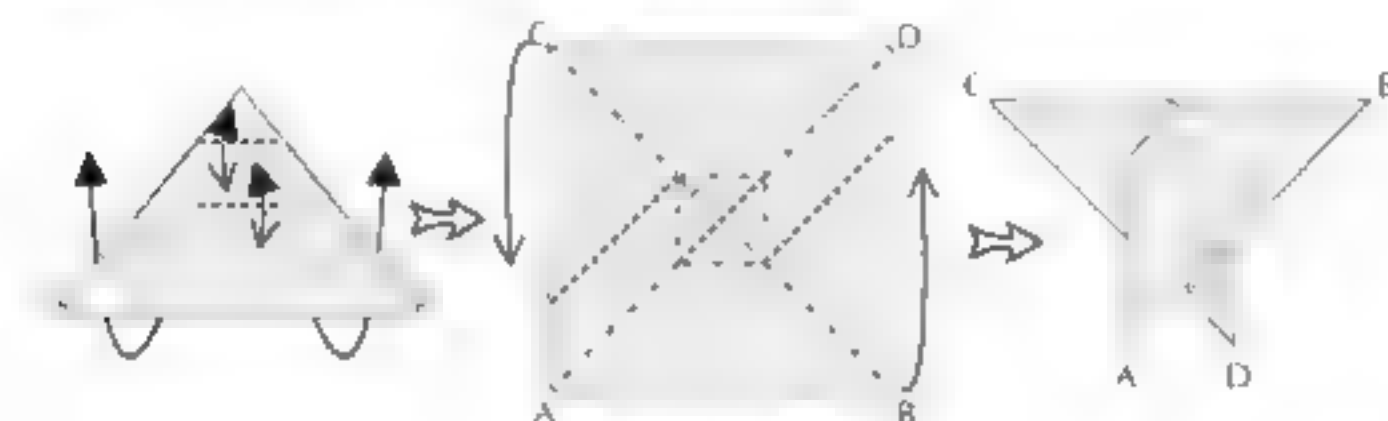


2. Completed preliminary base. To  
create a eight flapped bird base,  
petal fold each of the flaps.

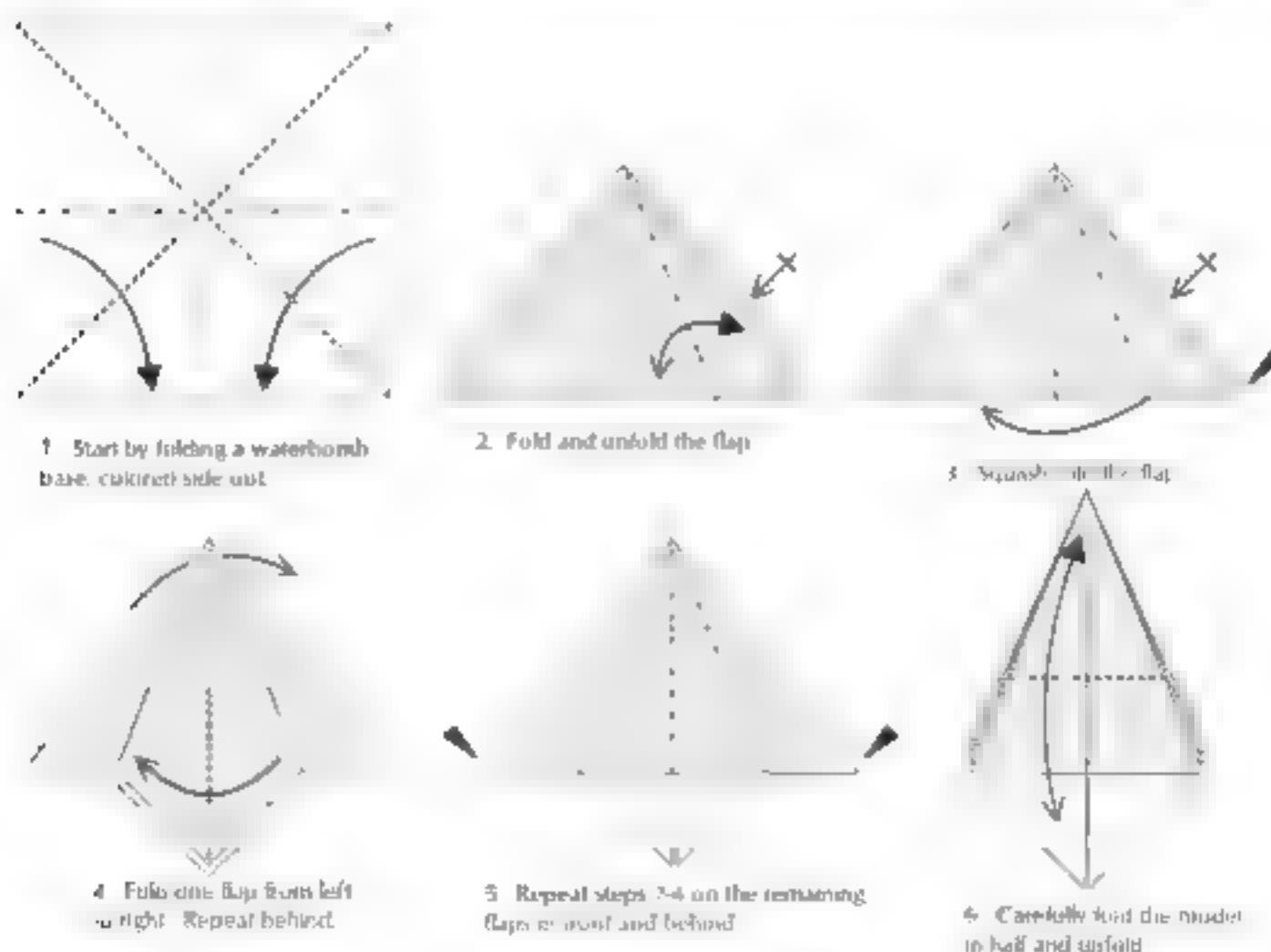
## Other Bases

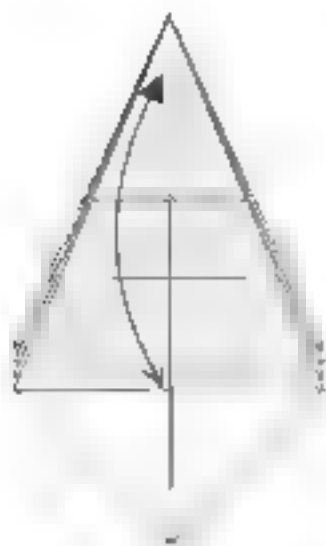
These bases were created either for a specific purpose or completely by accident while I was experimenting with solving one problem or another. Some of them, like the spider bases, are utilized extensively in this book, but others have yet to be used, though they do show promise. I've included them as potential doodling material for exploring creators.

**Butterfly Base** This base is used in the Frost Dragon and Peter Engel's Butterfly. It was created by sinking the top of a waterbomb base, pushing the edges of the sink together, and flattening out the result. The structure of the base is easier to illustrate using a construction. Start by folding a waterbomb base, creasing where indicated and untolding the paper. The level of the sink can be adjusted to change the proportions of the base to produce differing results.



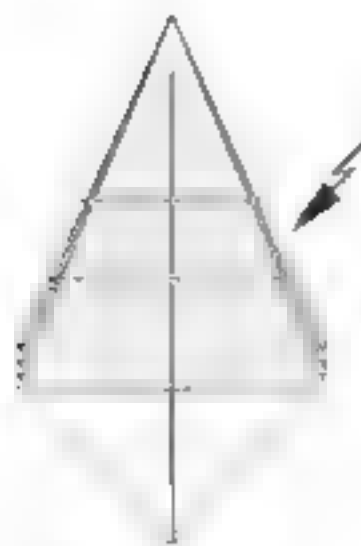
**The Spider Bases** These bases were my earliest creations. I folded them first while attempting to create my dragonfly model, and discovered that through a slight modification many variations were possible. They are used in my "Dragonfly," "Wolf Spider," "Tarantula," "Octopus," and "Comet" models.



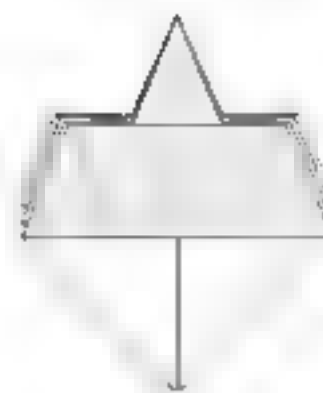


#### STANDARD CONFIGURATION:

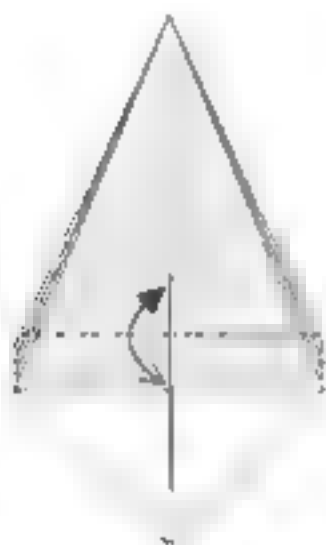
1. Fold the tip down to the raw edge and unfold.



2. Execute a crimp sink on the two creases.

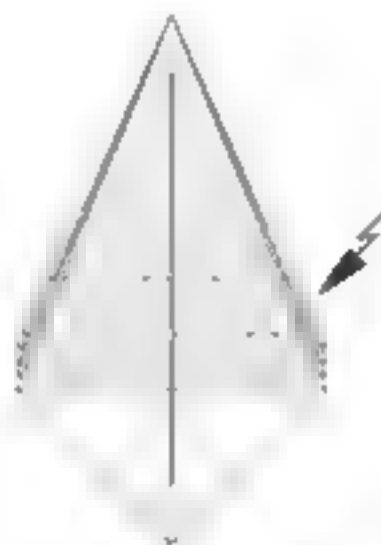


3. Completed spider case, standard configuration. This base is used when folding the Dragonfly and Cerberus.

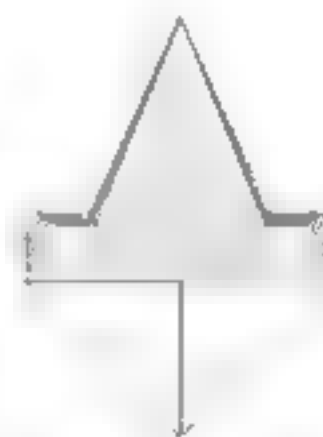


#### LOWERED CONFIGURATION:

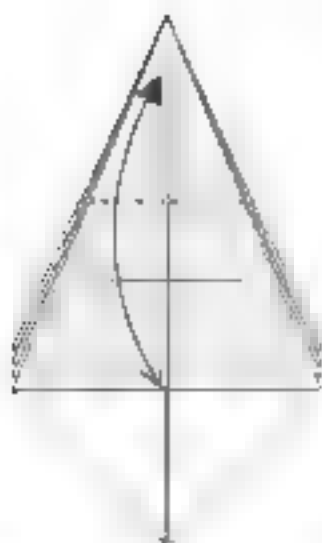
1. Fold the crease down to the raw edge and unfold.



2. Execute a crimp sink on the two creases.

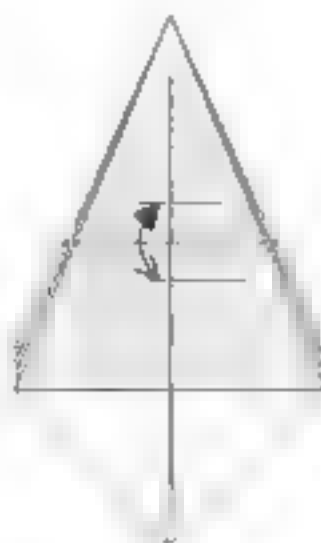


3. Completed spider case, lowered configuration. This base is used when folding the Octopus and Tarantula.

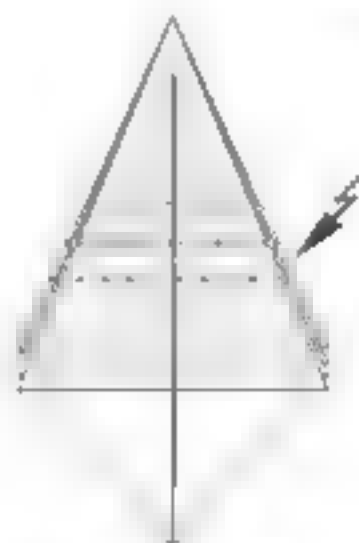


#### RAISED CONFIGURATION:

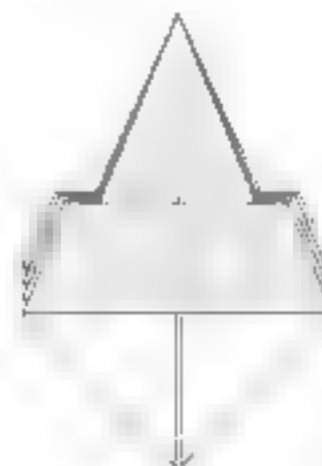
1. Fold the tip down to the raw edge and unfold.



2. Fold the second crease down to the first crease and unfold.

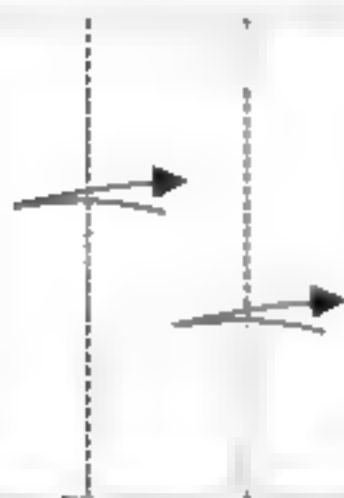


3. Execute a crimp sink on the two lower creases.

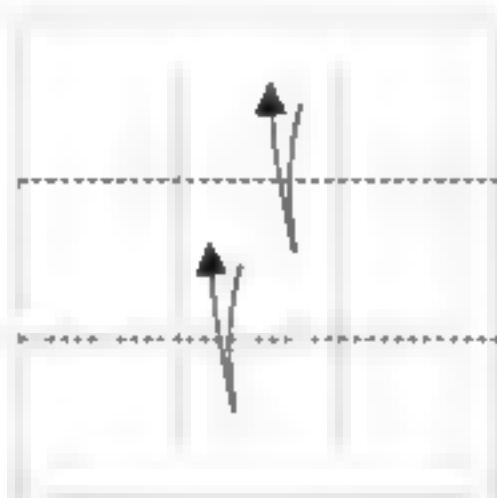


4. Completed spider case, raised configuration. This base is used when folding the Wolf Spider.

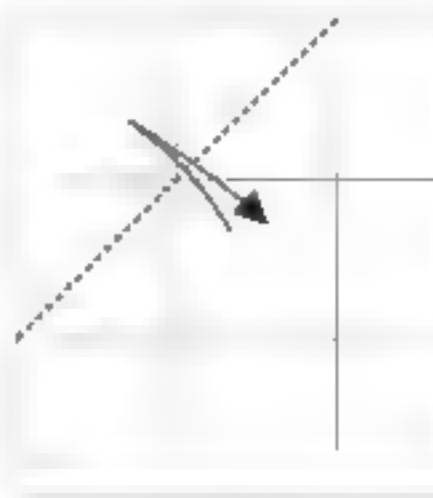
**Inverted Windmill** I've always been intrigued by the windmill base and by the fact that it consisted of four connected preliminary bases. So in my investigations I spent much time trying to create an analogous version using waterbomb bases. It turns out that the true analogue is the petal folded waterbomb base which is described previously, but this base was the final result of my initial experiments. I've never attempted to use it for anything, but I'm sure there are several enticing models waiting to be found within its folds.



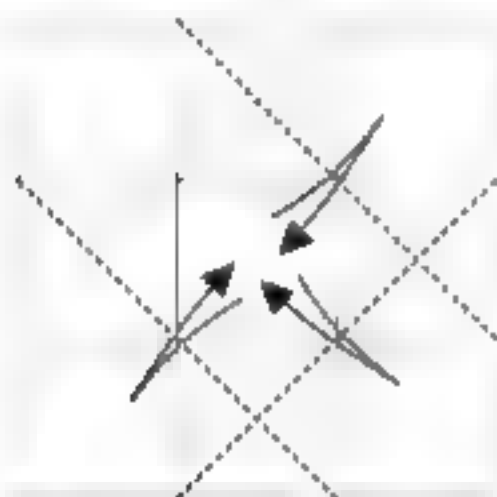
1. Fold and unfold the paper in thirds vertically.



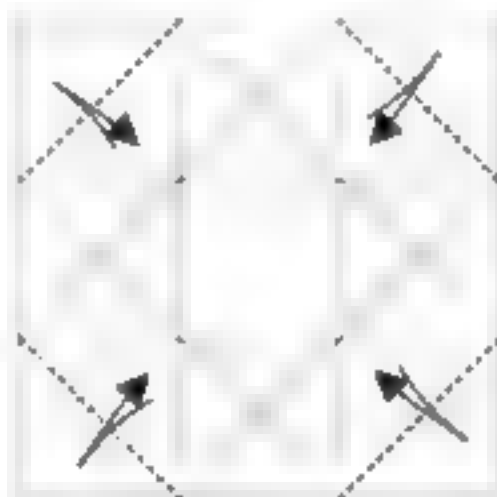
2. Fold and unfold in thirds horizontally.



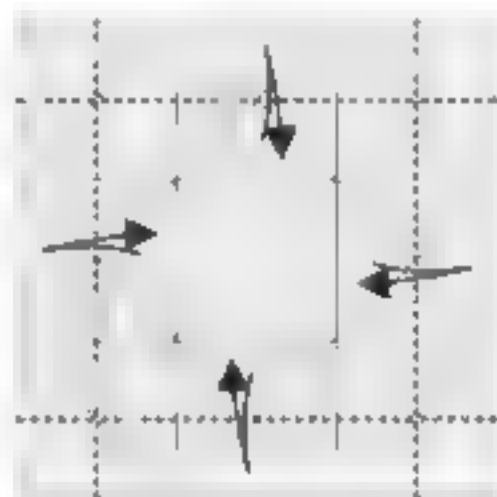
3. Fold and unfold the diagonal at the intersection of the two lines.



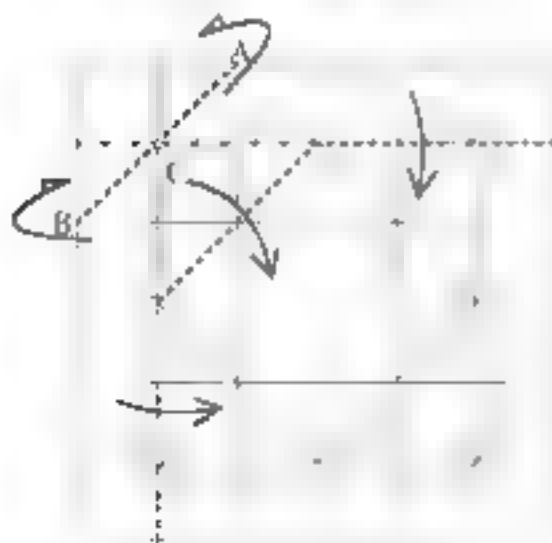
4. Fold and unfold the other three diagonals.



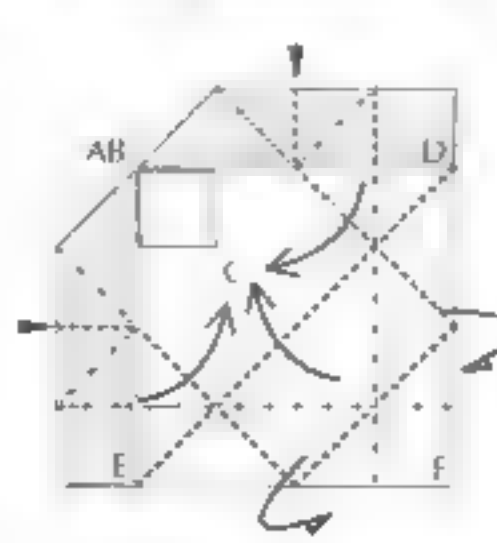
5. Fold and unfold the four corners. Turn the model over.



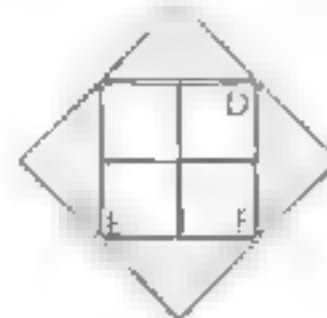
6. Crease the four lines and turn the paper over again.



7. This is similar to folding a windmill base except you are folding a preliminary and waterbomb base at the same time.

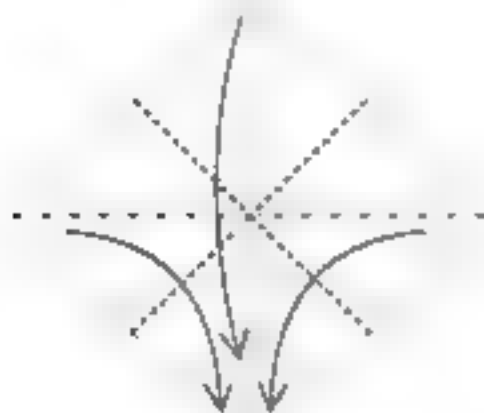


8. One corner completed. Create the same structure on the other three.

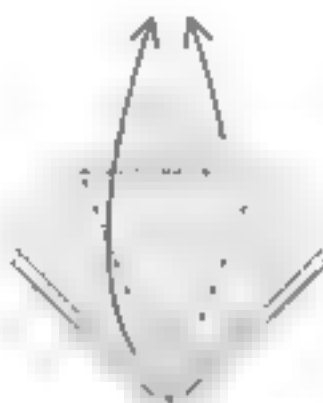


9. Completed base.

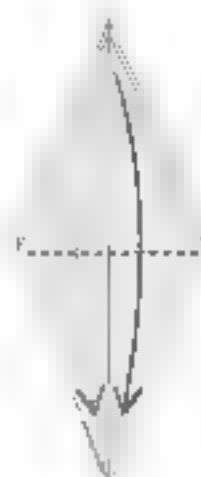
**Fairy Base** This is the fundamental form that led to my creating my "Fairy". It is a slight modification of the bird base, but contains many interesting possibilities. Shown here are two completed forms from which one might embark.



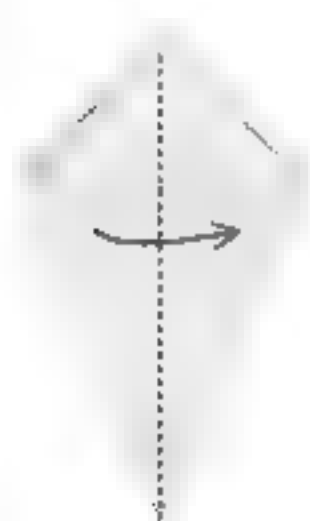
1. Start with a preliminary base.



2. Petal fold the front and back flaps.



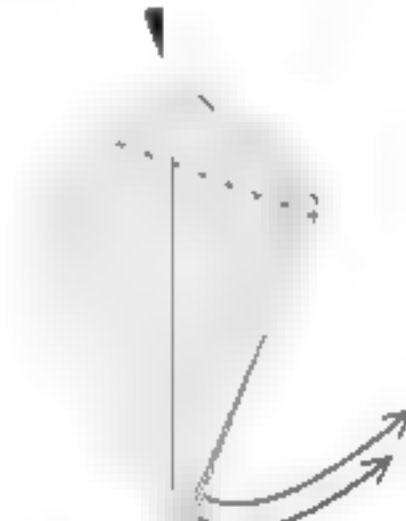
3. Fold the flaps back down.



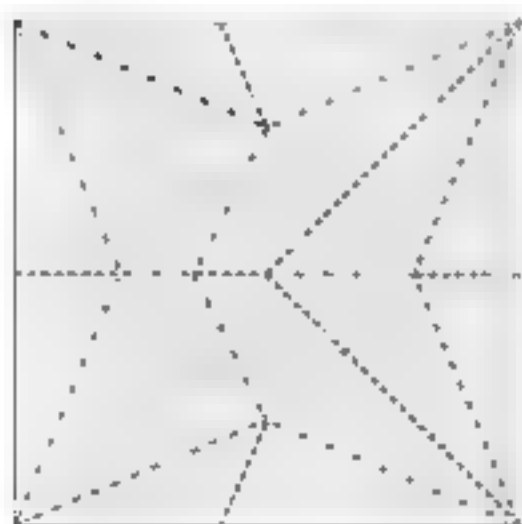
4. Fold one flap to the right.



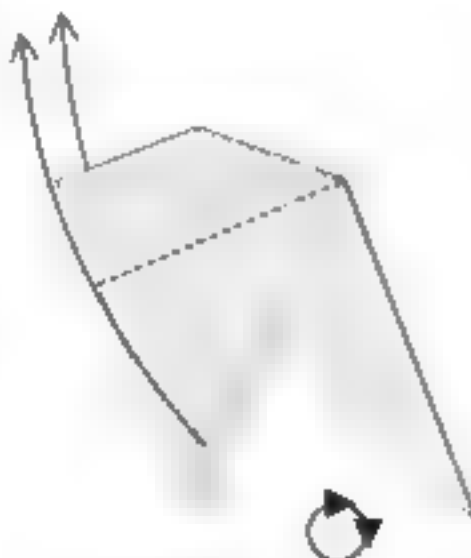
5. Fold and unfold.



6. This fold is similar to a sink, but as you execute the fold, swing the two inner flaps to the right.



(This is a construction map of step 6)

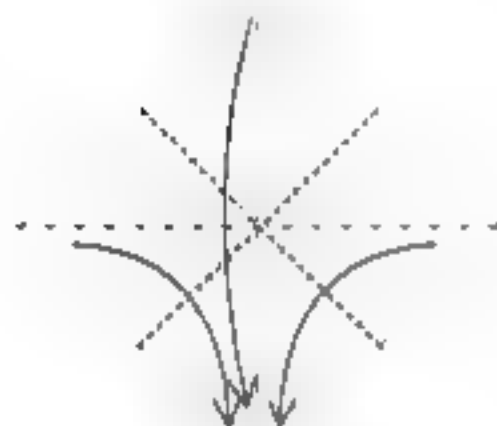


9. This is one completed form. Alternately, fold the flaps upward.

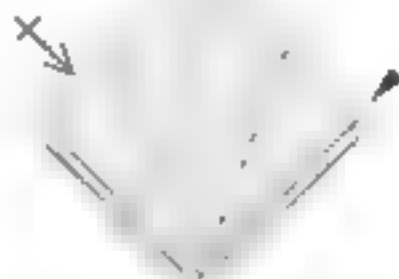


10. like this.

**RC's People Base** This base was designed by my friend RC Coushaw. He introduced me to it at the '92 convention as a form that was excellent for designing people, because it contains good proportions of paper for creating detailed heads and arms. It is basically a hybrid between the frog base and the bird base with some additional detailing. I've also made multi-legged versions from six and eight flapped preliminary bases. The folding sequence shown here is probably significantly different from his original design, because I forged the original folding approach and had to reverse engineer it from an existing base, but the ultimate result is correct. In any case, the form is very interesting and is not only well suited for creating people but many other subjects as well.



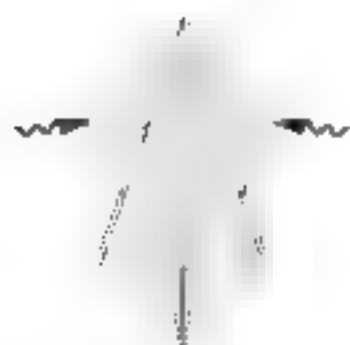
1 Start with the preliminary base.



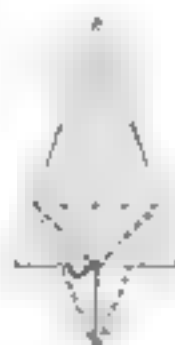
2 Reverse fold the flap. Repeat behind.



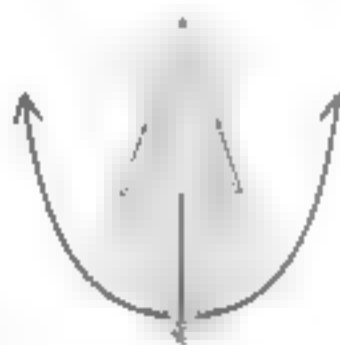
3 Square fold the remaining flaps in front and behind.



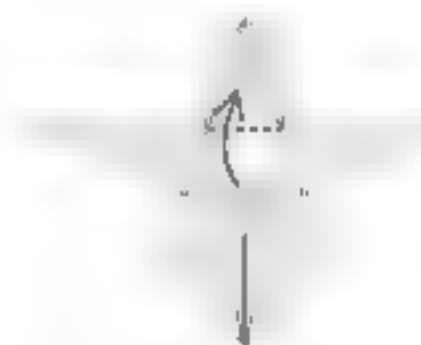
4 This is the interesting intermediary form. To proceed, please sink the side flaps.



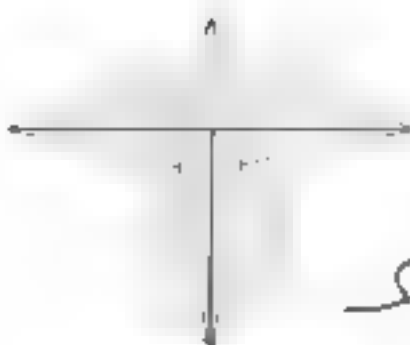
5 Petal fold the flap inside.



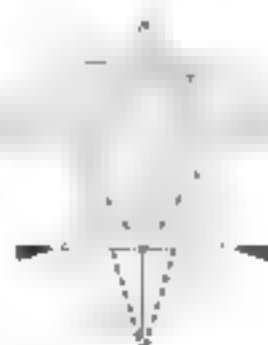
6 Reverse fold the two points upward.



7 Fold the flap upward.



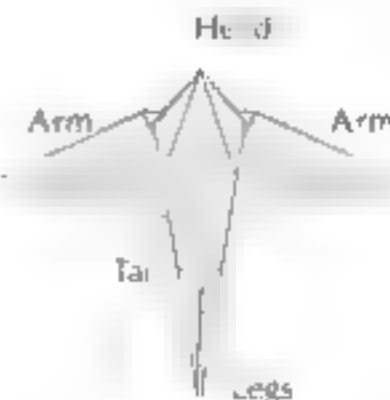
8 Turn the model over.



9 Reverse fold the two side flaps.



10 Please sink the sides.



11 Completed base







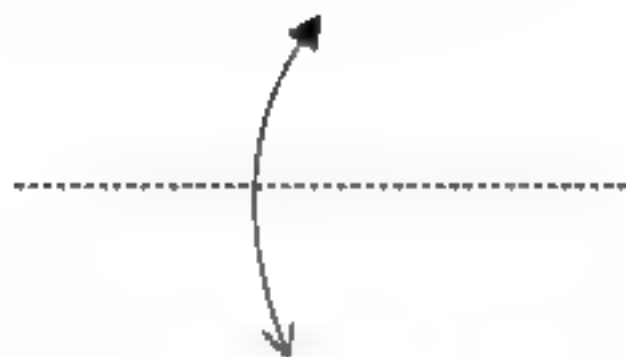
# Inspirations

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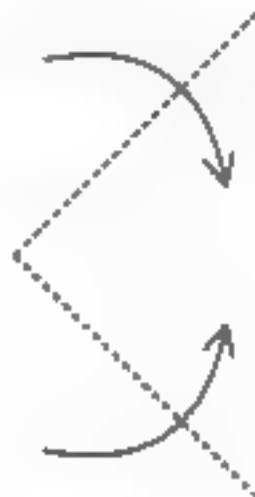
*"If I have seen further it is by standing upon  
the shoulders of giants" — Sir Issac Newton*

## Paper Airplanes Traditional

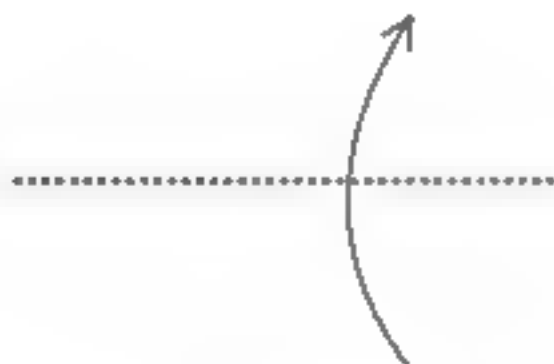
I've included these two models, the classic paper airplanes, because I'd never seen instructions for them in print, and I've always had trouble remembering the final steps of the second. So, here they are for anyone who has never been exposed to these simple but delightful toys, and for those who, like me, are too ditsy to remember them.



1. Fold the paper in half lengthwise and unfold.



2. Fold the two corners to meet the center crease.



3. Fold the model back in half.



4. Fold a single flap in half.



5. Turn the model over.

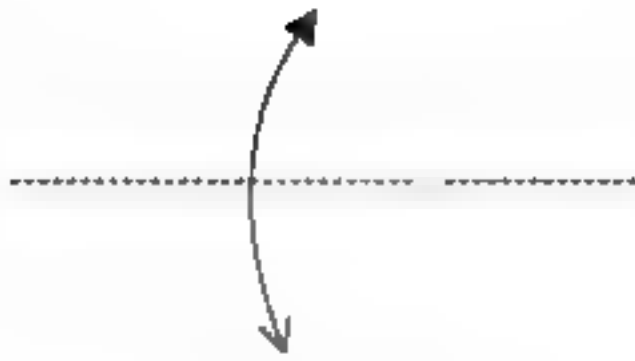
6. Fold the other flap in half.



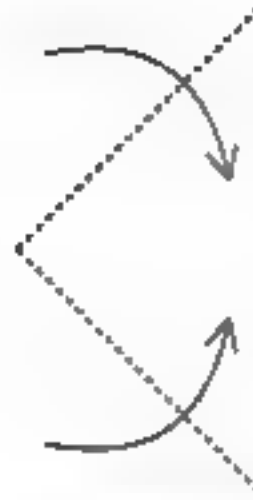
7. Fold wings halfway back up, into flying position.



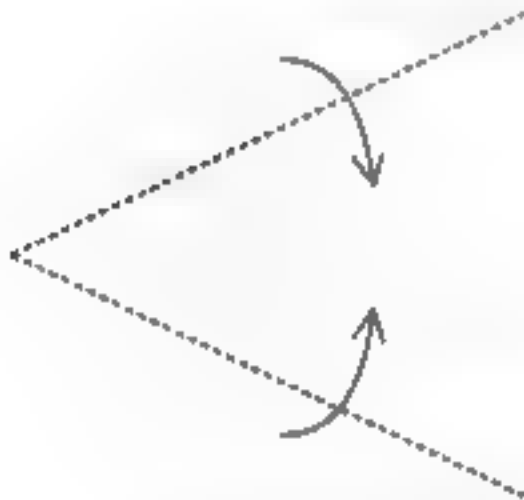
8. To fly, hold the model where indicated, and throw gently into the air.



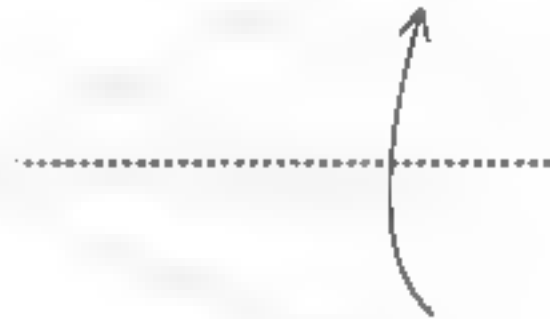
1. Fold and unfold the paper in half lengthwise



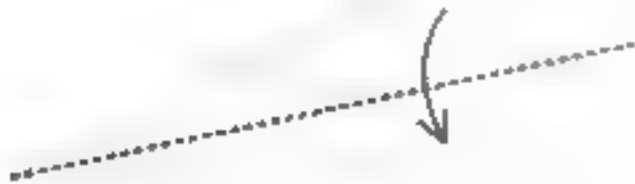
2. Fold the two corners to meet the center line.



3. Fold the edges inward again



4. Fold the model in half



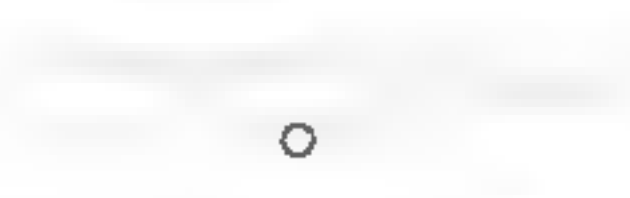
5. Fold the wing down.



6. Turn the model over



7. Fold the other wing down, then fold the wings up into position as with the previous mode



8. To fly the model, hold where indicated and gently throw it into the air. The dart will fly faster and further than the simpler airplane

## Cootie Catcher/ Fortune Teller - Traditional

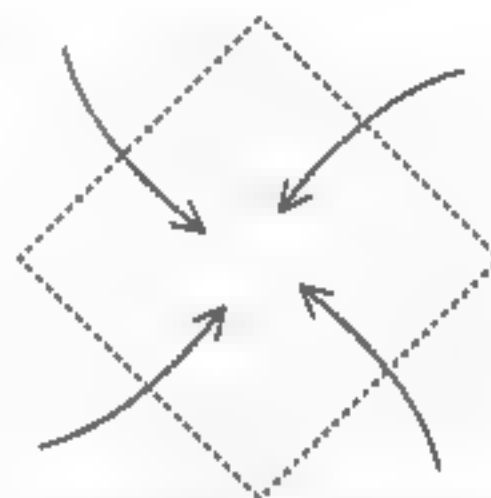
This is another piece that I remember from grade school, which I learned through my peers. It is actually an ancient model which was named "The Salt Cedar" because it could be turned upside down and used to hold spices. It is also one stage in the classic folding sequence "The Multiform" in which a square is folded from one form to another while the folder tells a story about a young boy in search of a gift for his mother. A wonderful rendition of this story can be found in "Paperfolding for Beginners" by Murray & Rigney.



1. Fold the paper in half lengthwise and unfold.



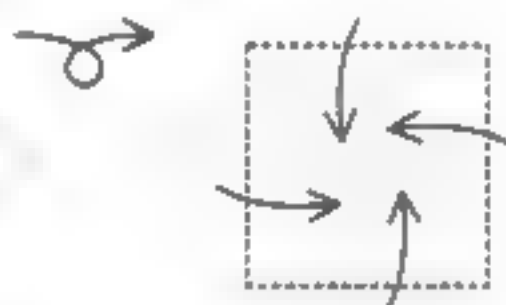
2. Fold the paper in half lengthwise in the other direction, and unfold.



3. Fold all four corners into the center. (This is called a 'blintz fold'.)



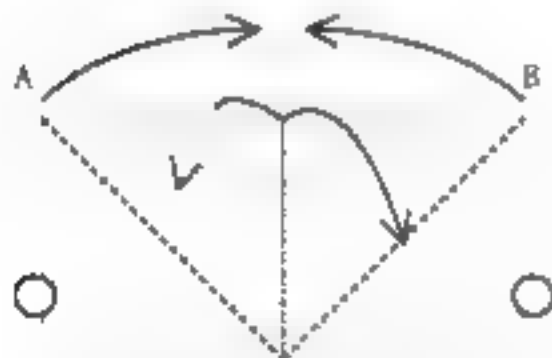
4. Turn the model over.



5. Blintz fold again.



6. Fold the model in half.



7. Grasp the two sides of the model where indicated and push points A & B together, allowing the front and rear thickness to move apart from each other. The model will not lie flat!



8. To complete the model, pull out the four single layer flaps.

9. Completed model.

There are two games that can be played with this model. Both involve inserting your fingers into the pockets of the model and manipulating it like a puppet. Insert your right thumb into pocket A and your right index finger into pocket B (as shown in figure I). Pinch your thumb and index finger together, causing the points of pockets A and B to meet. Do the same with your other hand in the other two pockets. (figure I). Now, bring the index fingers and thumbs of both hands together, causing all four points to come together (figure II). Next, open the model in the other direction by moving the thumb and index fingers of the other hand apart while keeping both thumbs pressed together and both index fingers pressed together (figure IV). With practice, you will be able to open in one direction, close, and open and close in the other direction in quick succession.

To make a fortune teller, open the model to step 6 and write a different number in each of the eight indicated triangles (figure V), then open to step 5 and write an answer to a yes/no question in each of the triangles, such as "It may come to pass" or "It is not clear. Try again" (figure VI). Fold the model back up and hold it as described above. Have someone ask a question that can be answered yes or no. Open the model so that the numbers show (as in figure II or IV) and have them pick one of the numbers. Next, close and open the model in the opposite direction, counting "ONE" and then close and open in the other direction, counting "TWO". Continue counting like this until the number chosen has been reached, and have them pick another number. Count again as before, closing and opening the model, and have them pick one last number. Unfold the model up to step 5 again; the answer to their question will be written underneath.

To make a Cootie Catcher, open up the model to step 6 and draw little "buggies" in the upper and lower triangles (figure VI). Then fold the model back up, and using only one hand, insert your thumb into one pocket and a different finger in each of the other pockets. By moving your fingers together and apart, you can get the model to open and close just as you did with two hands. Open it one way, and the model is blank, but open it the other way, and you see a bunch of buggies! (figures VII & IX). Show a friend the model opened, so that the blank portion is showing, then pretend you are using the model to pull something off his shirt, or out of his hair. Then open the model the other way so that the part with all the buggies is showing.



Figure I

B

A

Figure II

B

A

Figure III

B

A

Figure IV



Figure V



Figure VI

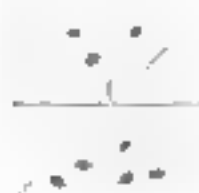


Figure VII

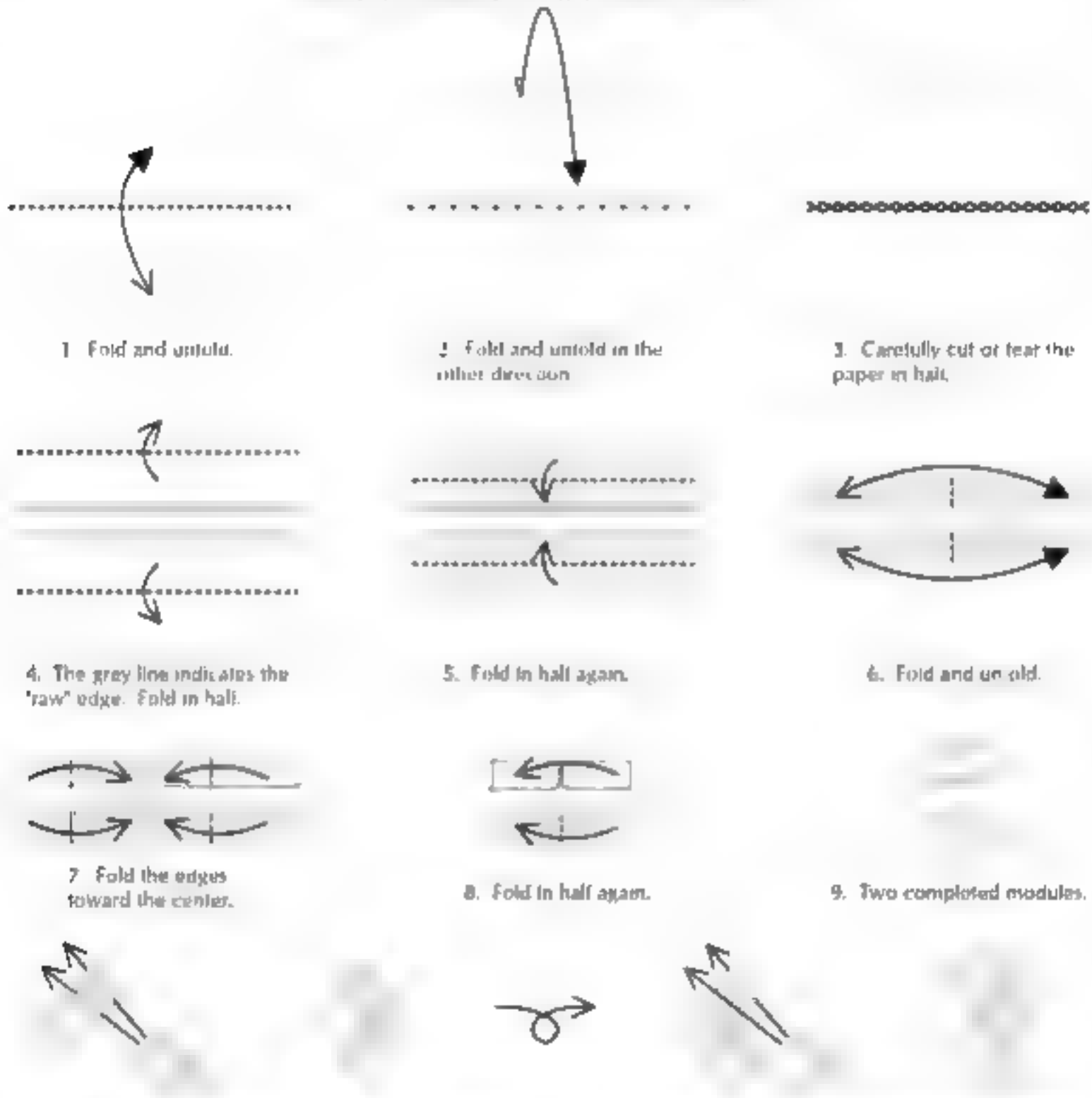


Figure VIII

Figure IX

## Gum Wrapper Chain - Traditional

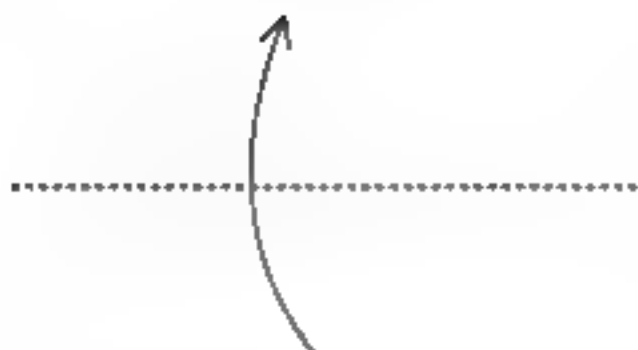
This is another model that I've never seen in print, and as a child saw people doing it from time to time. It is simple and fun, and can be done by the youngest of folders. The model is folded from the paper that is wrapped around sticks of chewing gum. The ratio of the sides of the wrapper is 4 x 5, and each wrapper produces two modules which are folded from 2 x 5 rectangles. I have also discovered that the for lines found in fortune cookies can also be used.



To make a chain, take one module and position it so that the raw edge is on the left and the folded edges are on the right. Position another module so that the raw edge is on the top and the folded edges are on the bottom. To merge the two together, push the prongs of second module through the slots in the first. Opening the raw and folded edges correctly makes this process easier. To add more modules, flip the chain over from left to right and repeat the process, always keeping the raw edge upward.

## Paper Football Traditional

This is not the most exciting piece, but it is a common fold that I saw in grade school. The paper football was used in a game in which two people would stand at opposite ends of a table and take turns pushing the "ball" with their finger toward the other end. A "touchdown" occurred when you managed to push the ball so that it rested partly over the end of the table without falling off. The extra point was scored by holding the ball on one pointed end and "kicking" it with a flicked finger through a field-goal created by the other player by placing their index fingers end to end with their thumbs pointing upward. The model is folded from a standard piece of 8 1/2" by 11" notebook paper.



1. Fold the paper in half lengthwise.



2. Fold the paper in half again.



3. Fold the corner upward.



4. Fold the triangle to the left.



5. Fold the corner back down.



6. Fold the triangle to the left again.



7. Repeat the fold 3 more times, rolling the triangle until you run out of paper.



8. To complete the model, fold the opposite corner down and tuck the flap inside the model as tightly as possible.

## Fish Traditional

As a child, I never tolded the fish, but I was exposed to the five "classic" bases, fish, waterbomb, preliminary bird and frog. Having never seen it I always wondered what the fish looked like so I've included it here.



1. Fold the paper in half diagonally and unfold.



2. Fold the edges in and unfold.



3. Fold the other edges in and unfold.



4. Fold the paper in half diagonally and unfold.



5. Fold a rabbit ear on the creases.



6. Fold another rabbit ear on the bottom creases.



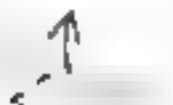
7. Turn the model over.



8. Fold the leftmost point to the center of the model.



9. Fold the model in half.



10. Reverse fold the tail through the center of the model.



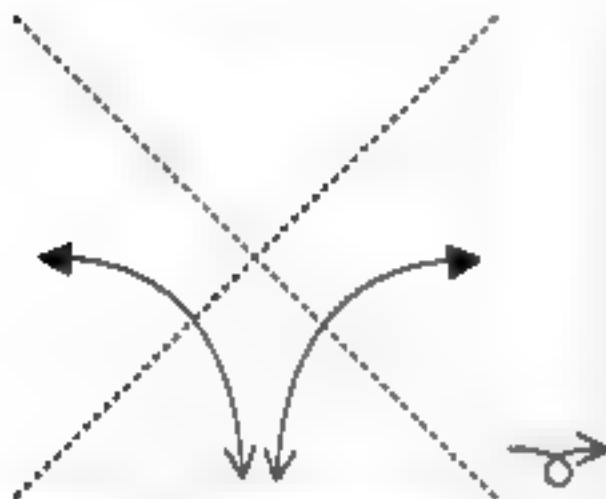
11. Fold the flap down to create a fin. Repeat behind.

12. Completed model.

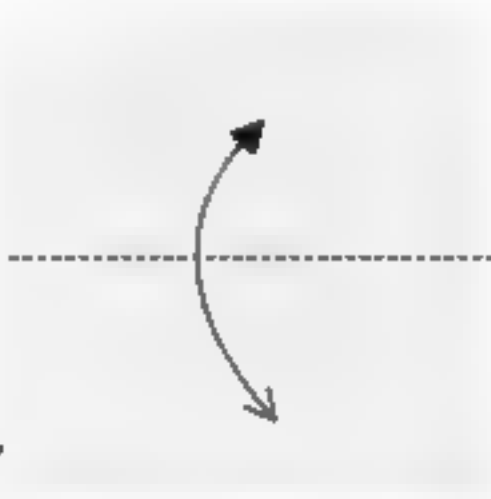


## Waterbomb Traditional

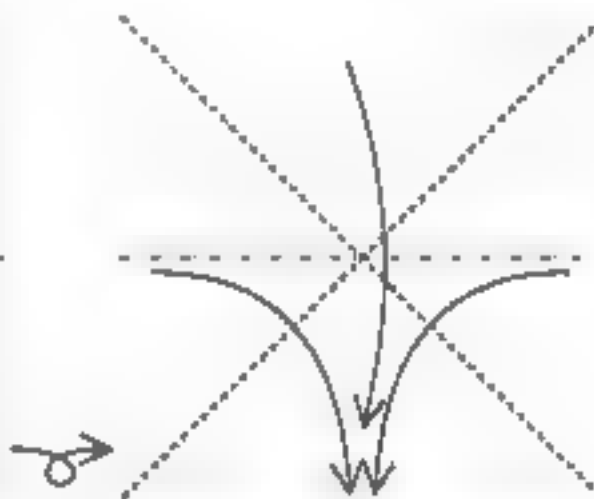
This is another traditional model from ancient Japan. I have seen it in almost every basic book on origami that I have encountered, but was first exposed to it in grade school when a Jewish student taught it to me. It is called the waterbomb because it can hold water, and if you throw it at someone, it will explode on impact and get water all over the place. But don't tell anyone where you found out.



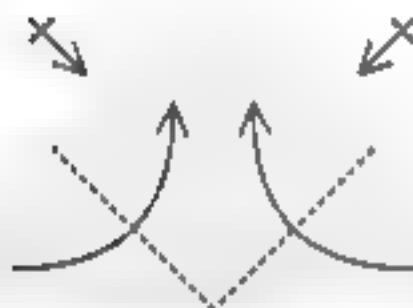
1. Fold and unfold the paper in half diagonally in both directions. Turn the model over.



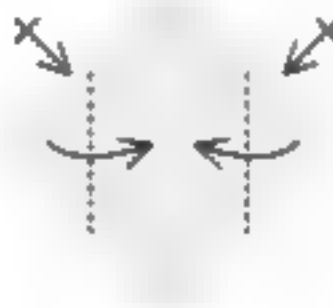
2. Fold and unfold the paper in half horizontally in one direction only. Turn the model over.



3. Bring the sides in to the bottom center, following the existing creases. Turn the model over.



4. Bring the two corner flaps upward. Repeat behind.



5. Fold the side flaps inward. Repeat behind.



6. Fold the tabs downward. Repeat behind.



7. Tuck the two upper flaps inside the slots in the lower two flaps. Repeat behind.



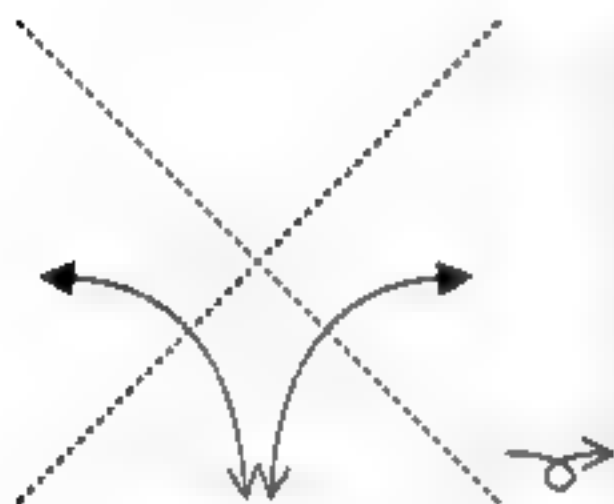
8. Inflate the model by tanning the four flaps and blowing into the bottom opening with a short, hard puff.



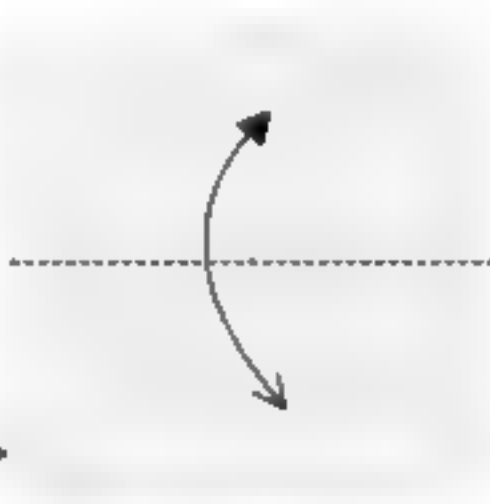
9. To complete the model, pinch each of the twelve sides to form sharp creases. To fill the model, carefully pour water into the hole where you inflated it in the previous step.

## Pagoda Bookmark Traditional

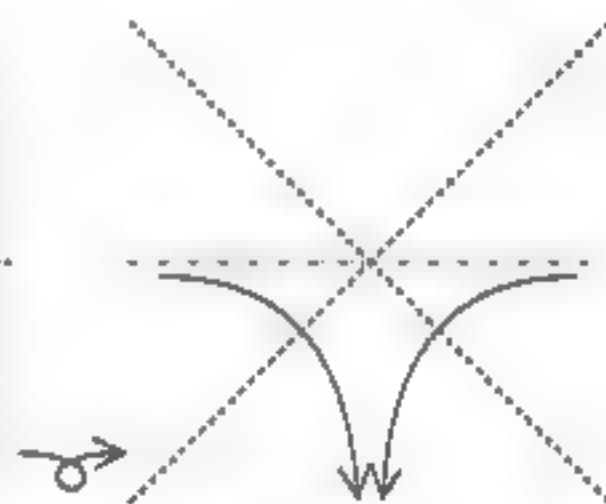
The pagoda bookmark was one of the first models I folded in miniature. In fifth grade I folded it from one inch squares, producing a model about three inches tall. I don't remember where I learned it, but I know I first saw it in an origami book. The model can also be found in "Paper Folding for Beginners" by Murray and Rigney, but I'm sure I learned it somewhere else.



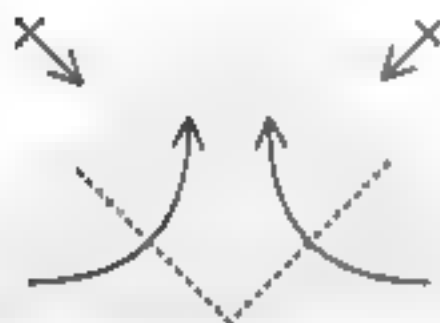
1. Fold and unfold the paper in half diagonally in both directions. Turn the model over.



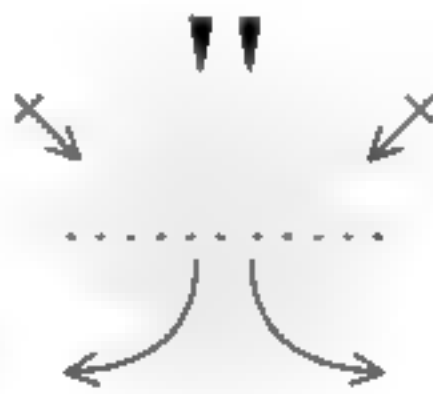
2. Fold and unfold the paper in half horizontally in one direction only. Turn the model over.



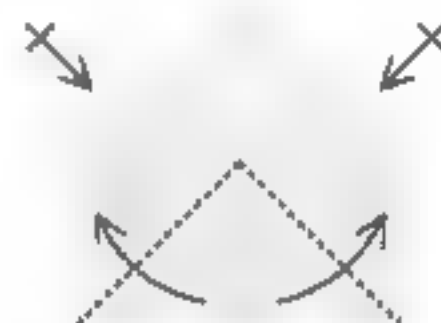
3. Bring the sides into the bottom center, smoothing the wing creases.



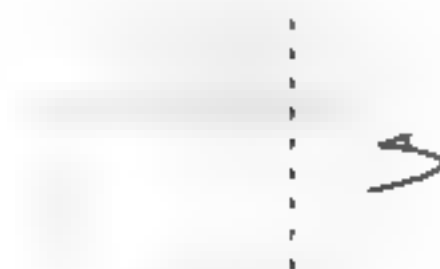
4. Bring the two corner flaps upward. Repeat behind.



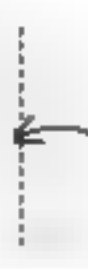
5. Squash fold the flaps downward. Repeat behind.



6. Fold the top flaps upward. Repeat behind.



7. Fold one flap behind.



8. Fold the rear flap inward.

9. Like this



10. Repeat steps 7-9 on the other side



11. Open the model by pulling the two flaps to the side. The dotted line shows a hidden valley fold. Repeat behind.



12. One module is complete. Fold additional modules and stack them together by inserting the prongs of one between the flaps of another.

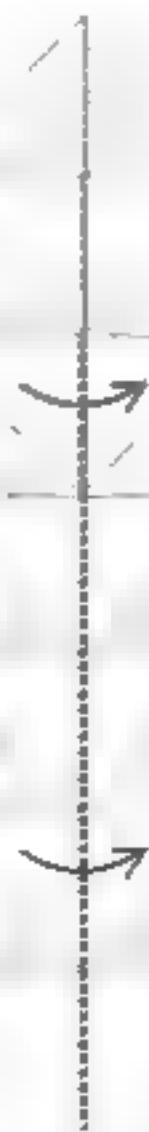
13. Like this.



14. To lock the modules together so that the model does not fall apart, fold one thickness to the left.



15. Tuck all the white flaps under the colored flaps to lock them in place.



16. ...and fold the flap back to the right.

17. To complete the lock, repeat steps 14-16 on the left side.

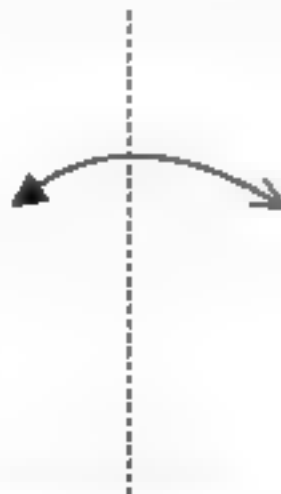


## Decorations Traditional

I was first exposed to these pieces in Robert Harbin's "Origami: A Step by Step Guide" the first origami book that I ever owned. Later I found several variations in "Secrets of Origami" another book by the same author. I enjoyed these models because they were simple and could be folded quickly yet were very satisfying. They are wonderful for teaching the importance of accurate folding. They can be folded from 10" paper by infants, and more advanced folders can go to smaller paper for a greater challenge. They also make excellent practice for folding miniatures. Try folding them from a 1" piece of paper using a bent paper clip or toothpick for the details.



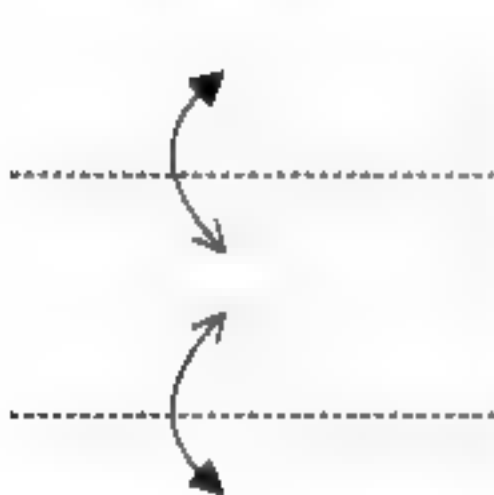
1. Fold and unfold.



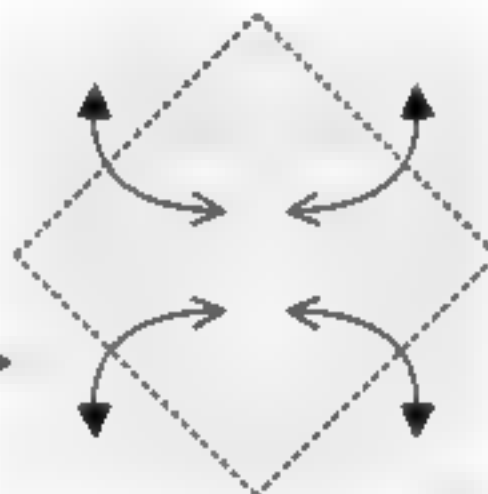
2. Fold and unfold.



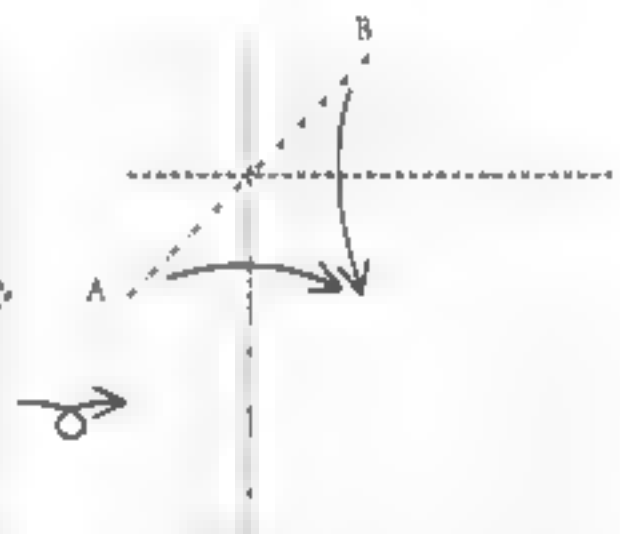
3. Fold and unfold.



4. Fold and unfold, turn over.



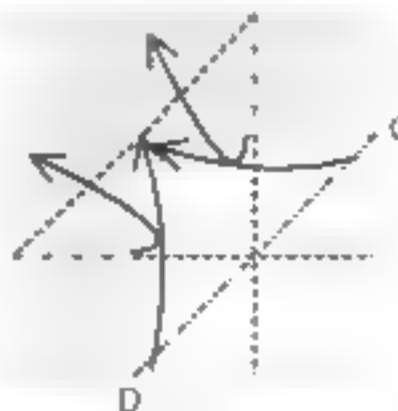
5. Fold and unfold, turn over.



6. Following the existing creases, bring points A and B to the center.

A B

7. In mid fold.

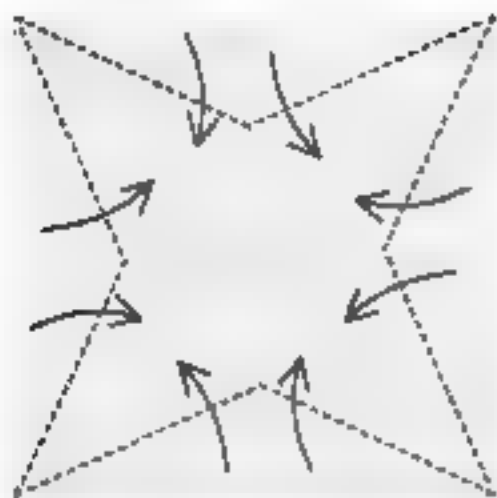


8. Do the same with C & D, causing all four corners to appear like the first.

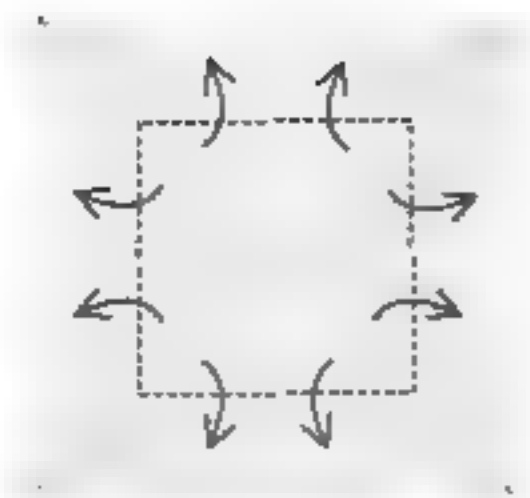


9. This is a windmill base.

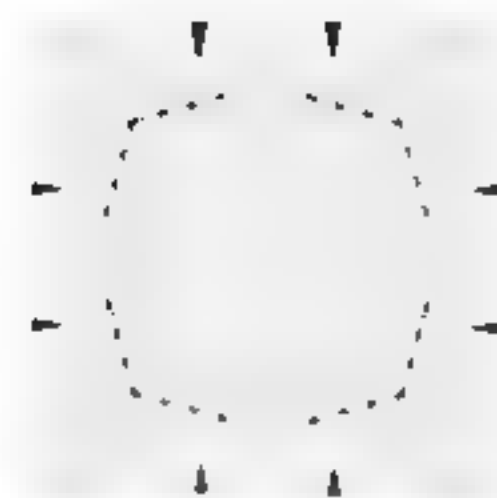
## Decoration I



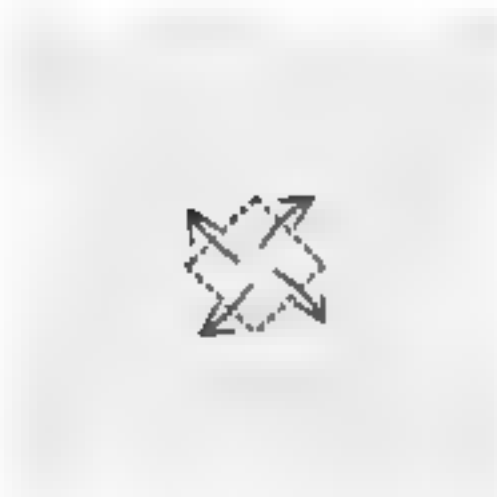
1.1 Start with step 9. Fold the eight flaps inward.



1.2 Fold the flaps so that they form a square



1.3 Squash fold each flap



1.4. Fold four flaps outward.

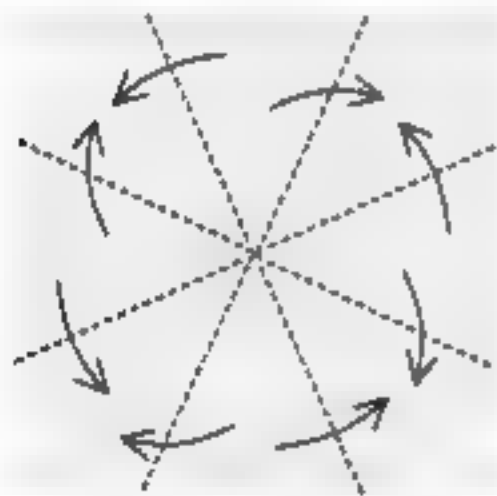


1.5. Fold another four flaps.

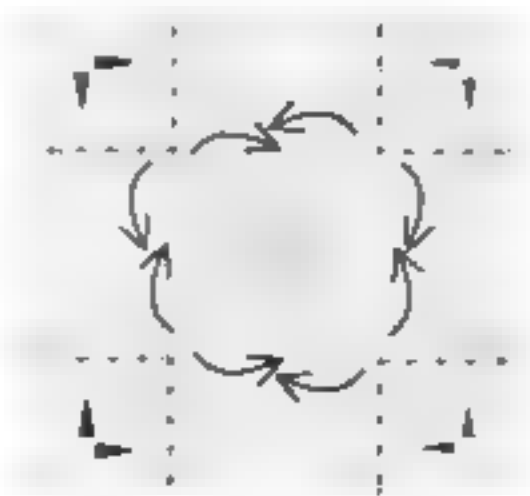


1.6. Completed Decoration

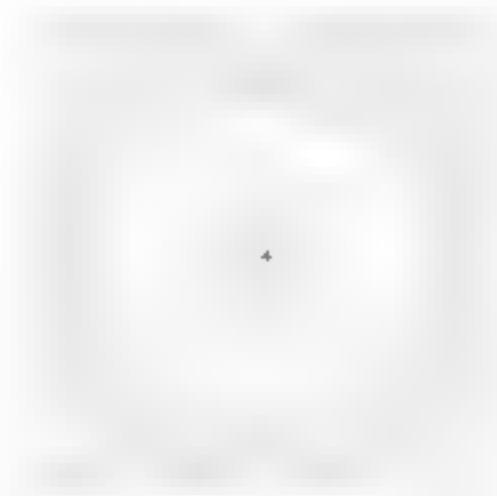
## Decoration II -



II.1 Start with step 9. Fold the eight flaps.

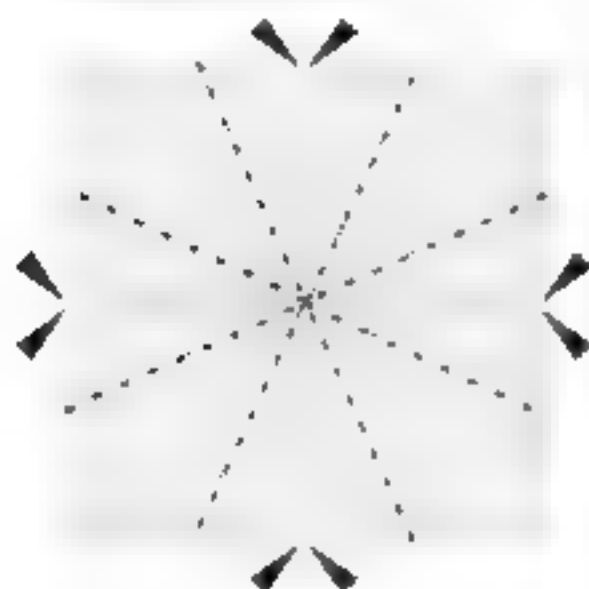


II.2. Squash fold the flaps.

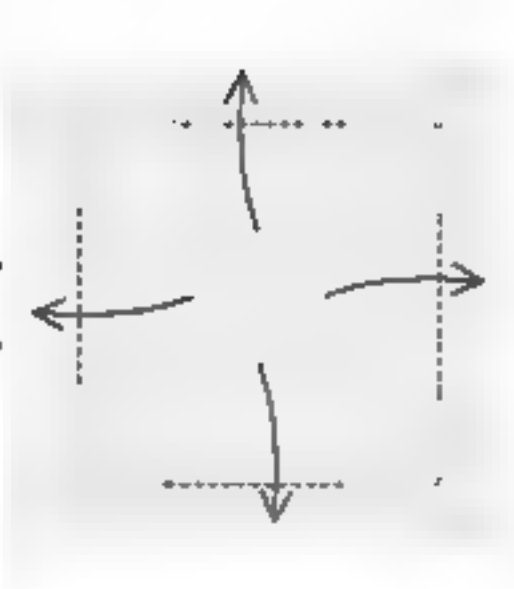


II.3. Completed Decoration II.

### Decoration III



III.1. Start with step 9.  
Reverse fold all eight flaps

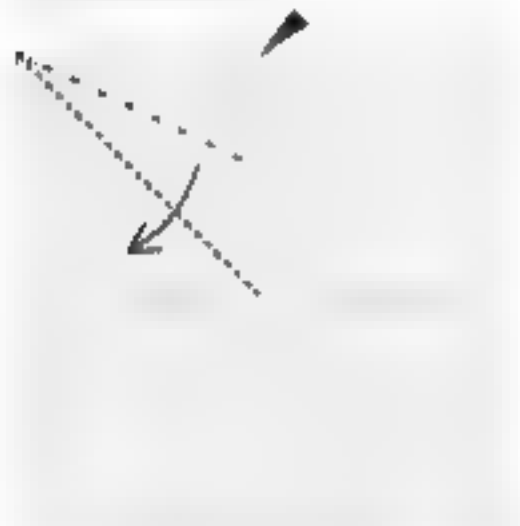


III.2. Fold the four inner flaps outward.



III.3. Completed Decoration III

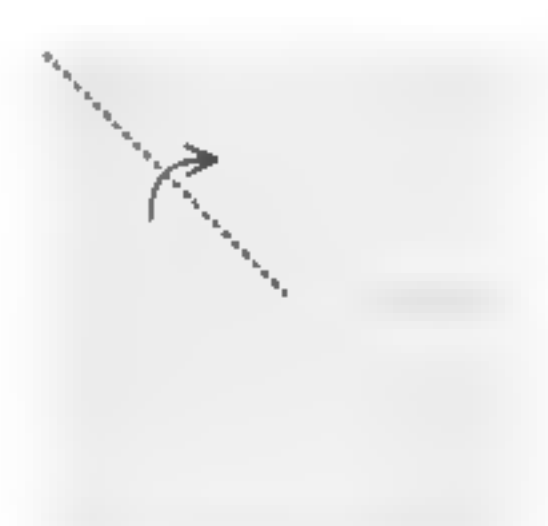
### Decoration IV



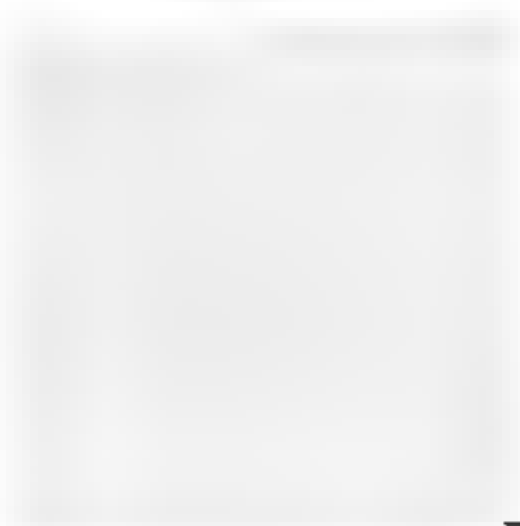
IV.1. Start with step 9.  
Squash fold the flap



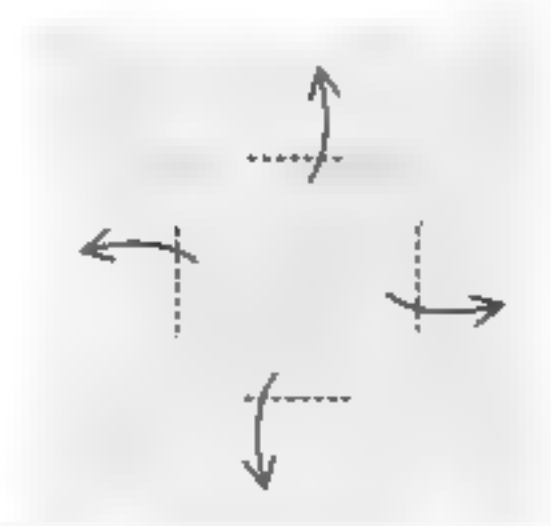
IV.2. Petal fold



IV.3. Fold the flap back



IV.4. Execute the previous three  
steps on the remaining seven flaps



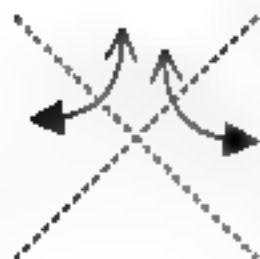
IV.5. Fold the inner flaps  
to the outer edges.



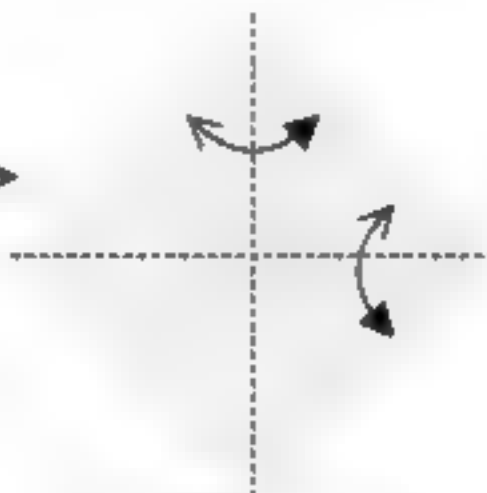
IV.6. Completed Decoration IV

## Crane (Orizuru) Traditional

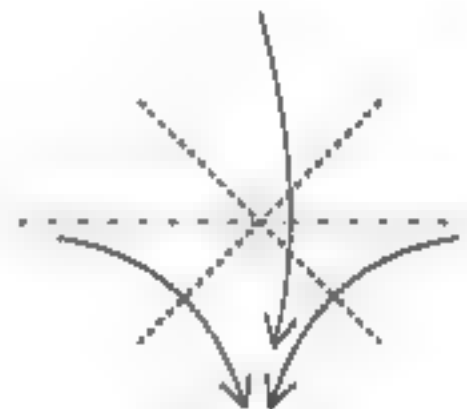
The crane is another ancient Japanese model and the most classic and recognizable of all origami forms. Many people who know little about origami will mention the crane as the one example they have seen. The crane is considered a symbol of luck in Japan and are used in traditional weddings. There is also legend that if you fold 1,000 cranes you will be granted a wish.



1. Fold and unfold horizontally in both directions. Turn the paper over.



2. Fold and unfold diagonally in both directions. Turn the paper over.



3. Bring all four corners together forming a preliminary base on the existing creases.



4. Fold in edges in.



5. Unfold the flaps.



6. Fold and unfold.



7. Place your fingers where indicated and bring the center point all the way up past the top of the model.



8. In mid-fold...

9. This is a completed petal fold. Turn the model over.

10. Repeat steps 4-9 on the other side.

11. Turn the legs in the front and on the other side with valley folds.



12. Reverse fold the head and tail.



13. Reverse fold the head again.



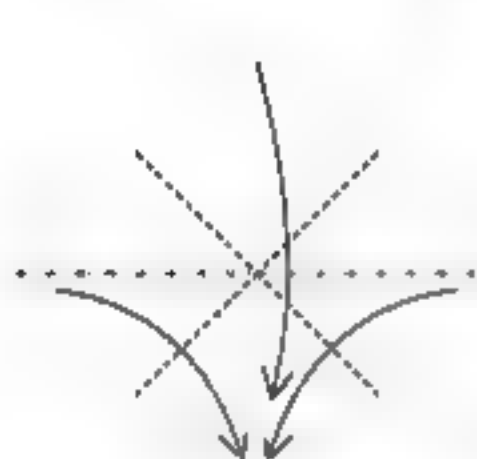
14. Gently pull the wings down, spread-squashing the center of the model.



15. Completed crane

## Frog - Traditional

The frog is another ancient model that has been passed down for many generations. As a child I saw it in many books, but also saw children teaching it to each other by word of mouth. It is attractive to them because it is an action model. If the back of the model is pressed down and then quickly released, it will jump. A stiff piece of paper such as standard origami paper (kami) works well.



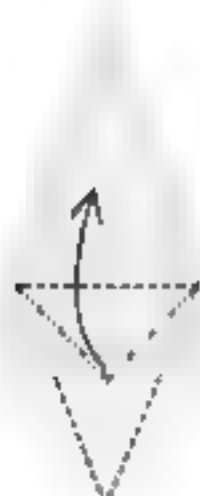
1. Precrease as indicated and bring all four corners together, forming a preliminary base on the indicated regions.



2. Squash fold a single flap.



3. Like this. Now repeat the fold on the other three flaps.



4. Petal fold the edge.



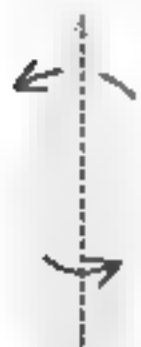
5. Like this, now repeat the petal fold on the other three flaps.



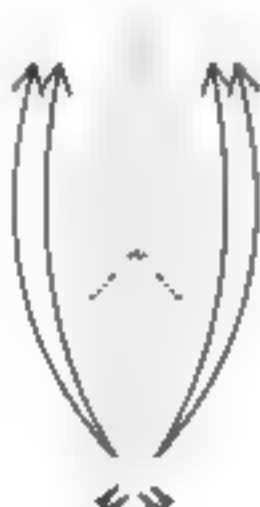
6. Fold one flap in front to the right, and one flap behind to the left.



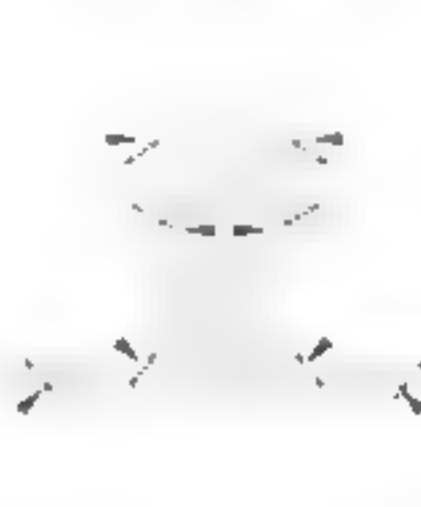
7. Thin the legs by folding the flaps in. Repeat on the other three flaps.



8. Fold one flap in front to the right, and one flap behind to the left.



9. Reverse fold the four legs upward.



10. Complete each of the legs with two reverse folds.

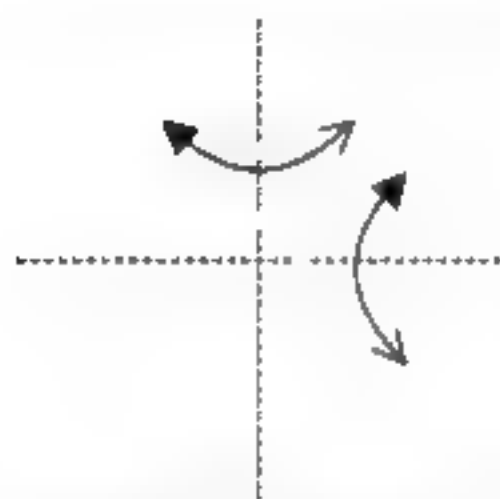


11. Completed model. To make it jump, press down where indicated, and let it spring loose.

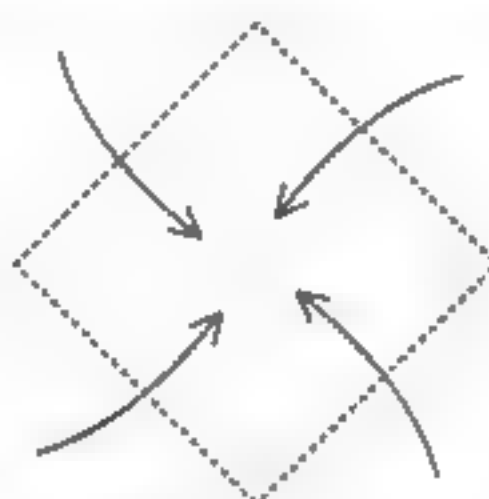


## Lover's Knot Traditional

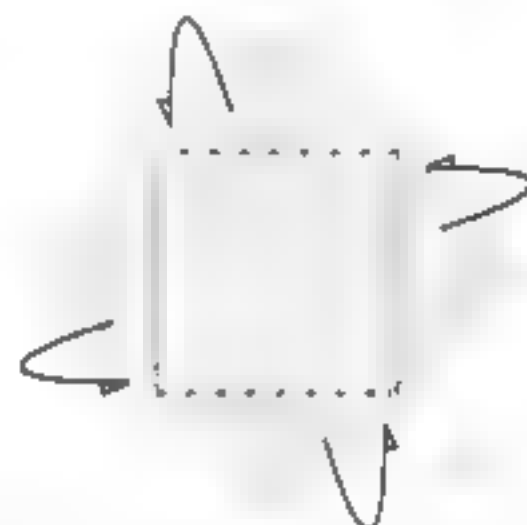
The Lover's Knot was always one of my favorite models. Probably because of the intricacy of the structure of the completed model, or perhaps, because it was the only model I knew of which was more difficult to unfold than it was to fold. In school I would write notes on square paper and then fold them into Lover's Knots and leave it up to someone else to try to unfold the note without shredding it. It is possible to unfold the model without backing out the spread-sink in step 8, but figuring out how is quite a puzzle.



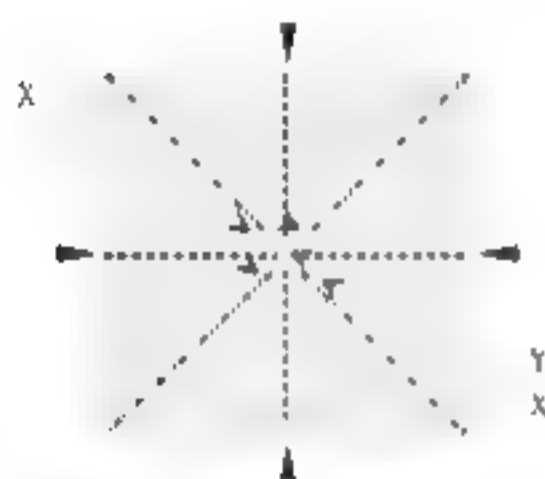
1 Fold and unfold in both directions.



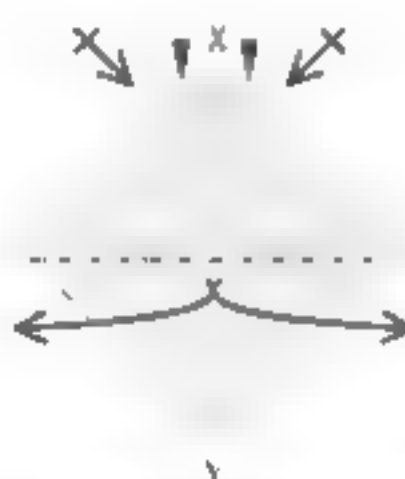
2 Hintz fold all four corners to the center.



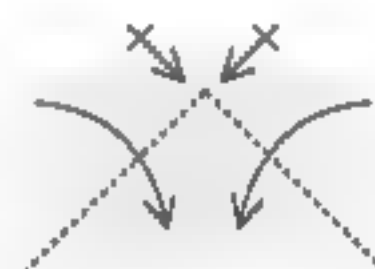
3 Hintz fold in the other direction.



4 Pinch the outer sides together causing the coloured, single ply flaps to pop upward, and the white area inside to pop downward.



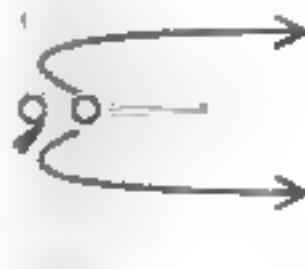
5 Squash fold the front two flaps. Repeat behind.



6 Fold the others downward Repeat behind



7 Rotate the model 45 degrees.

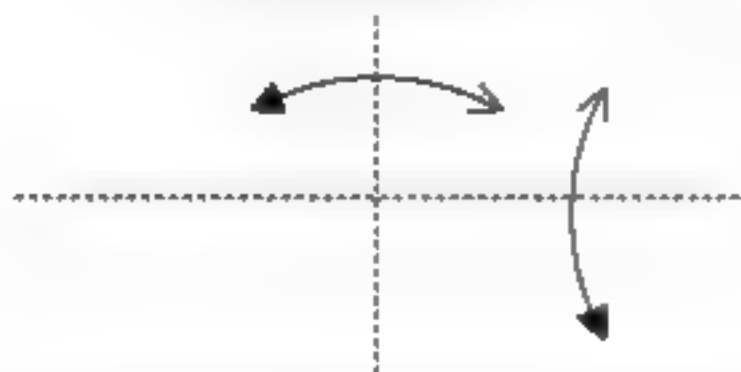


8 Pinch all layers of the left triangle together with one hand, and all layers of the right triangle together with the other hand. Pull the two sides apart, spread-squashing the center.

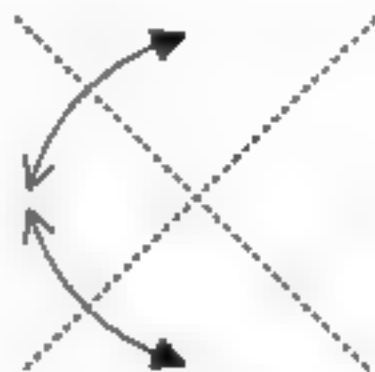
9 Completed Lover's Knot. Now, try to unfold it.

## It's Magic Fred Rohm

When I was first introduced to this model, it was described to me by a friend as "a bunny that jumps out of a box, and is impossible to fold." This started a competition to figure out the model before him. Eventually I did, and discovered that it is not an action model after all. Still, it is one of my favorites. It is not nearly as difficult as I thought, but it is more difficult than anything I've included in this book so far. A 5" by 10" rectangle produces a model 3 3/4" tall.



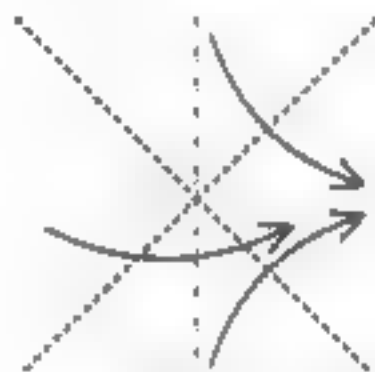
1. Fold the paper in half, and unfold in both directions.



2. Fold and unfold diagonally in both directions.



3. Fold behind and unfold.



4. Fold a waterbomb base on the creases.



5. Fold two points to the left.



6. Fold the two flaps to meet in the center.



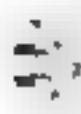
7. Unfold the flaps completely.



8. Reassemble, incorporating the indicated creases.



9. Fold the two flaps inside.



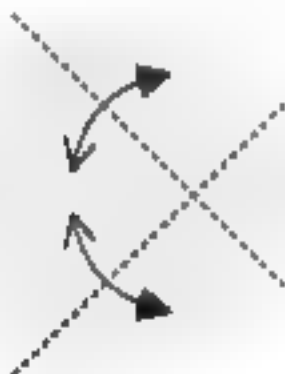
10. Fold the two diagonal flaps inside.



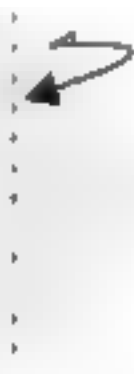
11. Fold the two corners to meet the center.



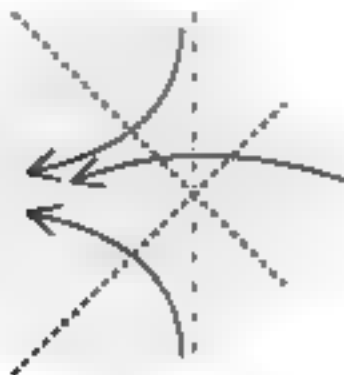
12. Turn the model over.



13. Fold and unfold along the two diagonals.



14. Mountain fold behind, and unfold.



15. Fold a Preliminary Base on the creases.

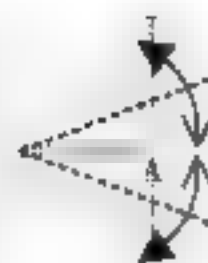
16. Like this



17 Fold and unfold the two flaps.



18 Swivel fold the two flaps locking the point A deep inside the model.



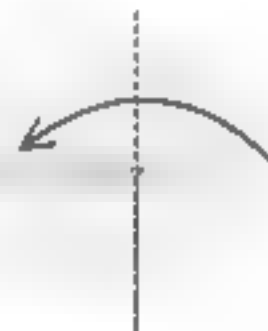
19 The dotted lines show the correct position of point A inside the model. Fold and unfold the two flaps



20 Petal fold to the right.



21 Pull out the loose paper from behind the two flaps



22 Fold the flap to the left



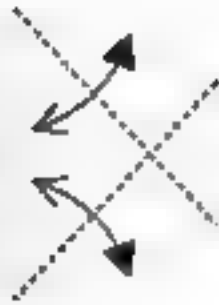
23 Reverse fold the two flaps



24 Reverse fold the four flaps.



25 Like this Turn the model over



26. Fold and unfold only the top thickness of paper.



27. As in step 1, fold a preliminary base on the creases, allowing the rear layers to swing out from behind. The model will not be flat.



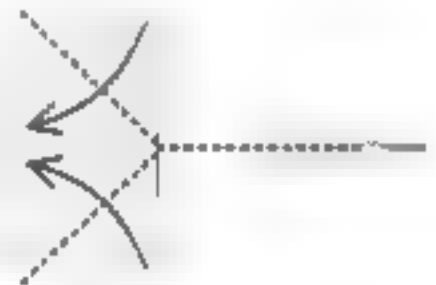
28. This is a 3-D view. Finish all layers together so that they meet in the middle.



29. Swing the two flaps to the left so that they lie flat against the bundle of flaps.



30. Like this. Turn the model over.



31. This is similar to step 2.



32. Fold and unfold the flaps.



33. Swivel fold the flap by folding point A to the right. Repeat on the other side.



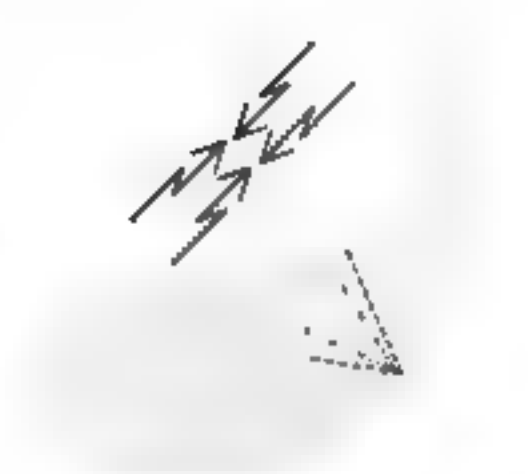
34. Reverse fold only the front flap on the arm. Repeat behind.



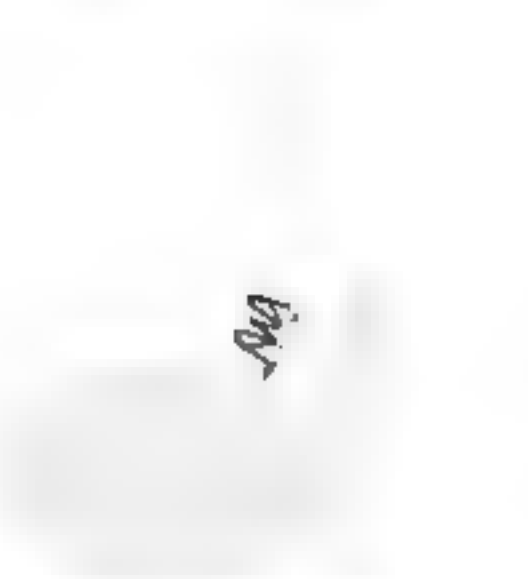
35 Reverse fold the next layer as indicated, repeat behind.



36 Fold the flap inside the model along the indicated line repeat behind.



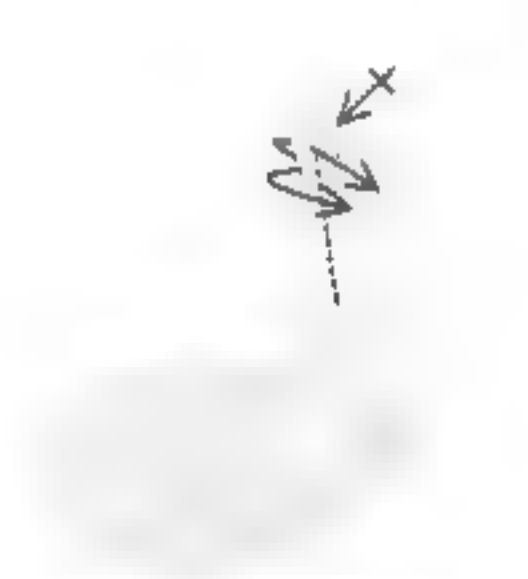
37 Execute the sharp fold. Sharp tweezers may make this fold easier.



38 Complete the back by folding the flaps inside the model.



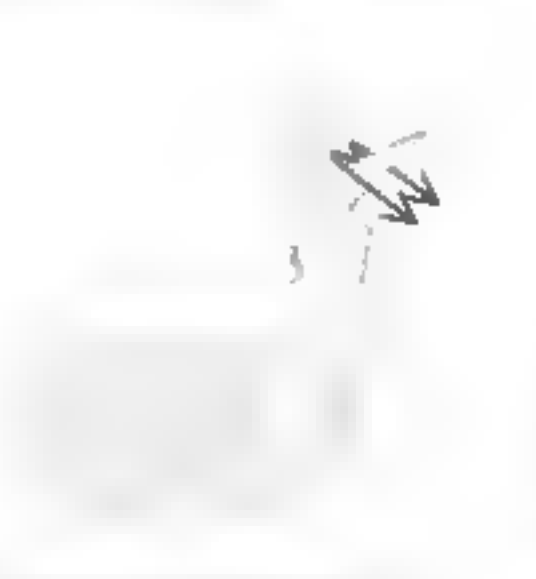
39 Fold and untwist the outside points to precrease the ears. Repeat behind but make the folds at slightly different angles.



40 Outside reverse fold the front and back points to create the ears.



41 Reverse fold the center point to create the head.



42 Pull down a single thickness of paper from either side of the head to make it wider.



43 Reverse fold the tip of the nose.



44. Continue forming the head by folding the two flaps inside.



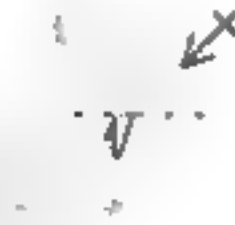
45. Complete the nose with a small crimp fold.



46. Reverse fold the arm into place. Repeat behind.



47. Complete the hands with small crimp folds.



48. Turn the arms by tucking the small flaps inside. Repeat behind.



49. Inflate the model by turning the rear flaps and blowing into the bottom opening with a short, hard puff.



50. To complete the model, pinch each of the twelve sides to form a sharp crease.

## Scorpion - Patricia Crawford

Of all the Crawford models I've included in this book, the Scorpion is the only one that could fold when I was young. Unlike most of her other models, it contains few constructions, and consists primarily of squash and reverse folds. In rediagramming it I discovered that I've always folded it incorrectly. If it is done right, the upper surface of each of the legs will be colored. It is easier to execute many of the leg folds the wrong way and end up with white legs, so follow the directions carefully!



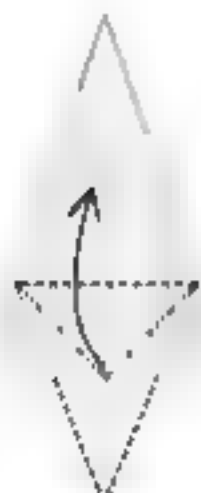
1. Bring all four corners together forming a preliminary base on the indicated creases.



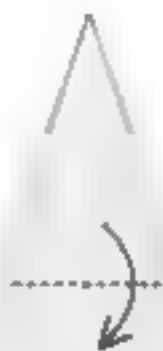
2. Squash fold a single flap.



3. Like this, now repeat the fold on the other three flaps.



4. Petal fold the edge.



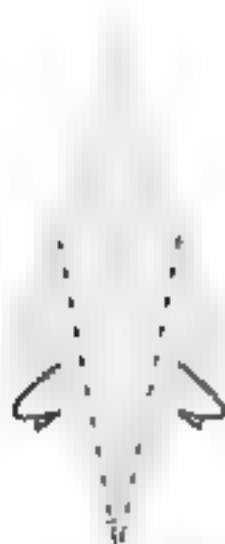
5. Like this, fold the tip downward.



6. Reverse fold two flaps along the indicated lines. The dotted line indicates the lowest crease.



7. Reverse fold the two white flaps inside the model.



8. Mountain fold the two flaps inside the model.



9. Valley fold the next two flaps inside.



10. Repeat the last two steps on the upper flaps.



11. Like this. Turn the model over.





1. Reverse fold the four flaps.



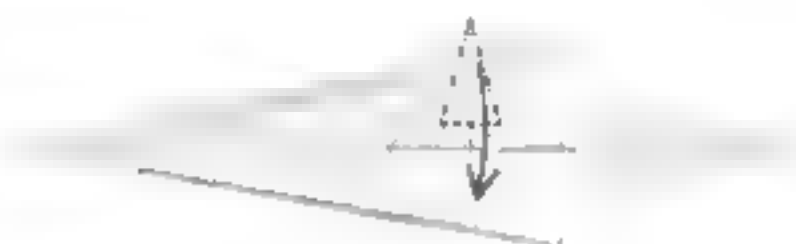
13. Petal fold the edge to the left.



14. Fold the two points to the left while reverse folding the white layers, this is similar to a petal fold.



15. The next four steps comprise a double rabbit ear. Squash fold the point.



16. Petal fold.



17. Fold the point back up.



18. Completed double rabbit ear. Fold the flap to the left.



19. Slide the leg into final position. Repeat steps 15-19 on the lower flap.



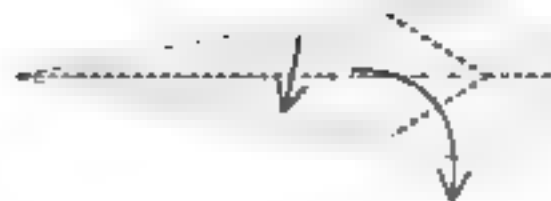
20. Reverse fold the next layer of flaps.



21. Reverse fold the final layer of flaps.



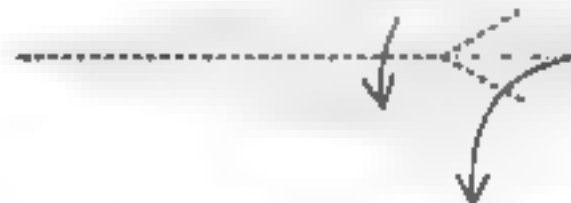
22. Fold two layers down from the top.



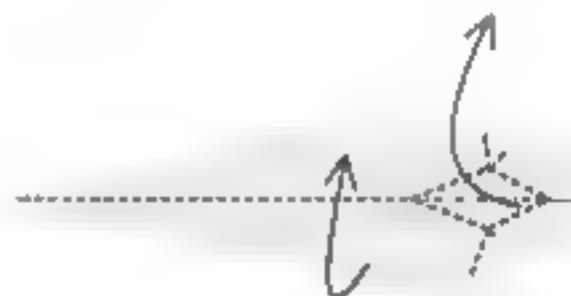
23. Fold the next layer down, incorporating a reverse fold.



24. Thin the legs with two reverse folds, one above the leg and one beneath. Both folds will wrap partly onto the white triangular area.



25. Fold the next flap down, again, incorporating the reverse fold.



27. Fold all the flaps back up, then incorporate the folds on the point to create the fourth leg the same way the second and third were created. This is simpler than it looks and is almost identical to steps 25-26.



26. Thin the legs with two reverse folds as in the previous step.



29. Tuck the six small flaps inside the model by either mountain folding or sinking.



28. Repeat steps 22-27 on the other side.



31. Fold the flap inside the model.



30. Like this. Turn the model over.

32 Reverse fold the two points

33 Take this.  
Reverse fold again.

34 Outside reverse fold.

35 Pull out some loose paper. Pinch the tail in a piece.

36 This is a detailed view of the tail. Execute three crimp folds, being careful not to split the paper open at the rear.

37 Reverse fold the tip of the tail.

38 Pull down three thicknesses from either side of the tail.

39 Pinch the ends to create the stinger.

40 Completed ant.

41 Detail of the pincer. Crimp fold the end.

42 Fold the small corners inside.

43 Complete the pincer by inserting your finger and rounding it out.

44 Completed pincer. Repeat steps 41-44 on the other side.

45 Completed model.

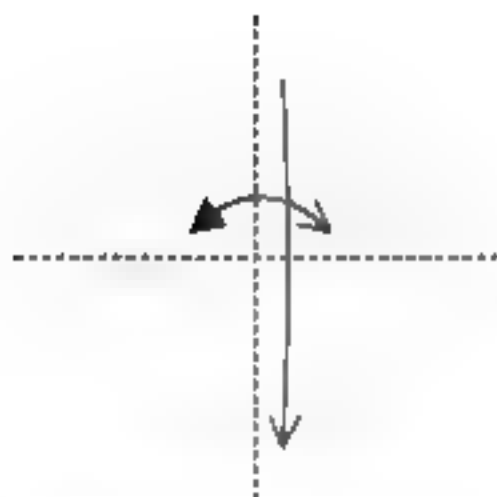
## Unicorn - Patricia Crawford

In correspondence with Patricia Crawford, I learned that this model came to her one night in a dream complete and intact. She woke up the next morning and folded it. It is the most spectacular example of inspired creation of which I know.

This model was always a wonder to me. I've loved mystical creatures such as unicorns and dragons my entire life, and as a novice origamist I thought that to fold this model would be the ultimate accomplishment. I tried time after time but my attempts failed miserably.

There are several folding sequences which are tricky. The model is built upon a stretched bird base with some additional internal structures, and I could never figure out how to get from the unstretched base to the stretched version, because no one had ever taught me the procedure. It seems I might have once completed the procedure by accident, and then couldn't get past the subsequent reversing steps. It is also easier to orient the internal structures incorrectly than it is to get them right. To make the model easier to understand, and eliminate these pitfalls, I've redesigned the folding sequence slightly, clarifying the steps that I found confusing.

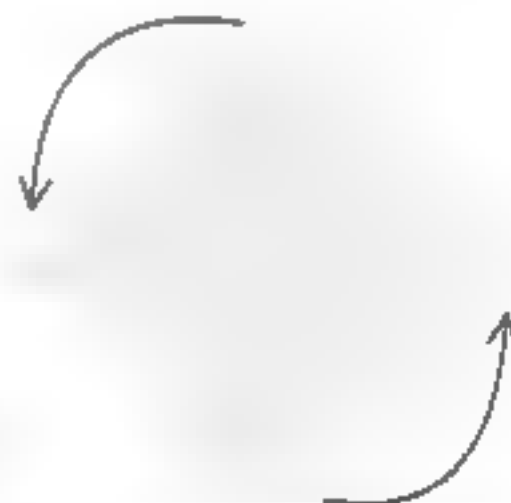
The model should be folded from origami foil or foil backed paper. A 10" sheet of paper leads to a model approximately 4" long. It also makes a wonderful miniature. Try folding it from a 3" piece of Japanese foil.



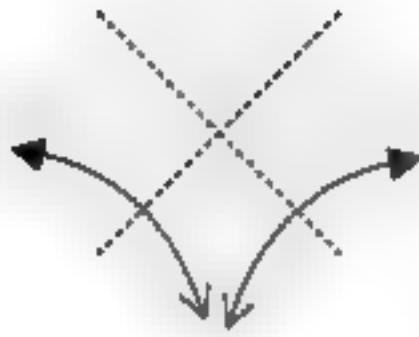
1. Fold and unfold the paper in half along one diagonal, then fold and leave folded along the other diagonal.



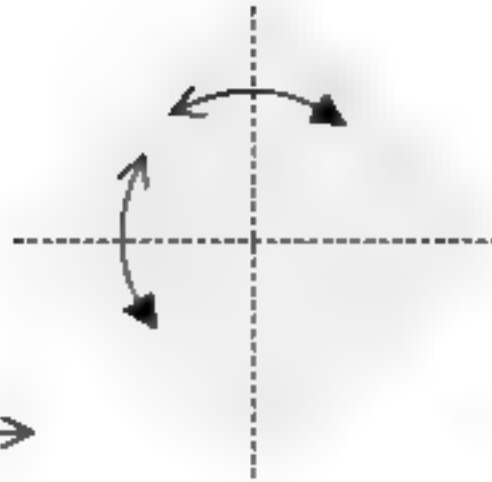
2. Fold the corners inward.



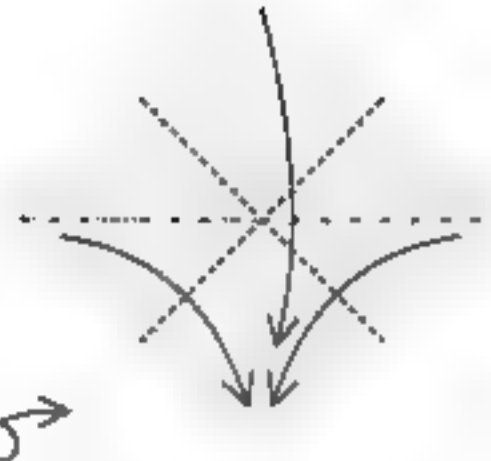
3. Enlarged view. Rotate the model 90 degrees counter-clockwise.



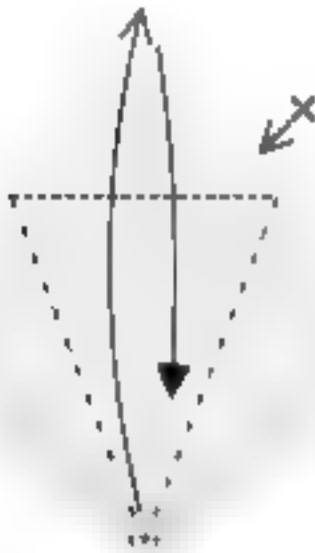
4. Fold and unfold in both directions. Turn the model over.



5. Fold and unfold. Turn the model over.



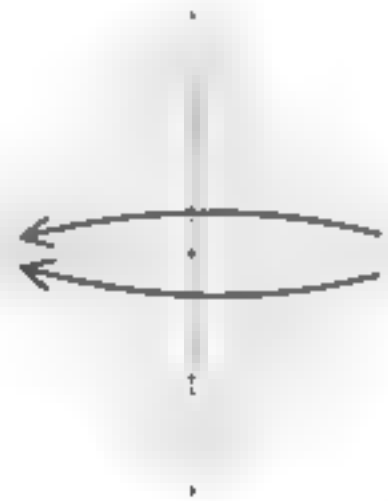
6. Carefully fold a preliminary base on the existing creases.



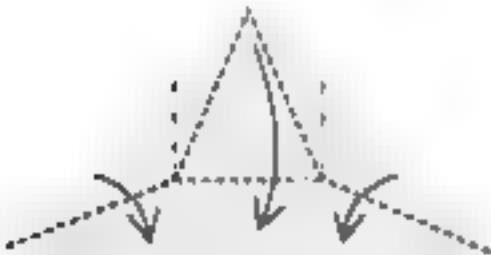
7. Repeat fold all the layers upward and fold the flap back down. Repeat behind.



8. Unfold the model to step 6.



9. Fold the two points to the left.



10. Fold the point downward following the existing creases.



11. Rabbit ear the flap to the right.



12. Repeat steps 10-11 on the bottom flap.



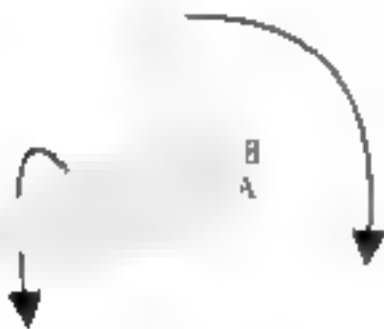
13. Fold the model in half.



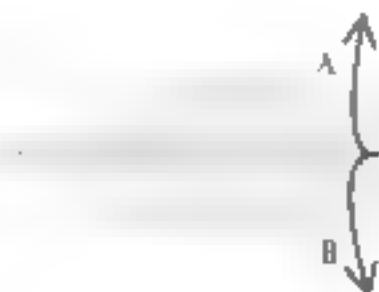
14. Fold the flaps to the left.



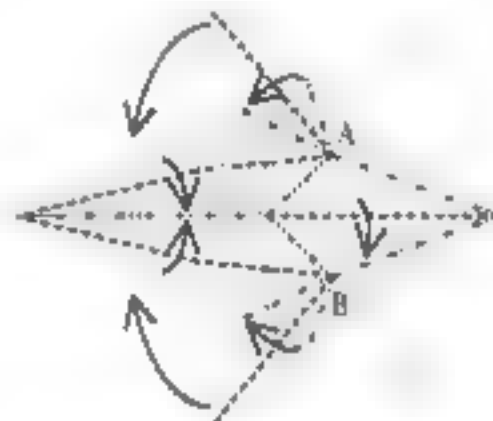
15. Inside reverse fold the point.



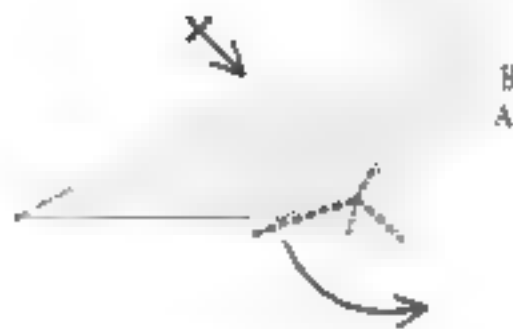
16. The purpose of the next three steps is to execute a wrap on points A & B. Unfold the model to step 13.



17. Open the model partially.



18. Reverse the direction of points A and B, then fold the model back up, following the existing creases, to a position similar to step 16.



19. Rabbit ear the front leg. Repeat behind.



20. Reverse fold the hidden points.



21. Fold the flap in half. Repeat behind.



22. Fold the back of the leg in half in the opposite direction. Repeat behind.



23. Pull one thickness to the right. Repeat behind.



24. Watch carefully. Reverse fold the back leg asymmetrically. Repeat behind.



25. Reverse fold the back leg asymmetrically again in the opposite direction. Repeat behind.



26. Thin the back of the leg by one fourth, repeat behind.



27. Reverse fold the tail upward



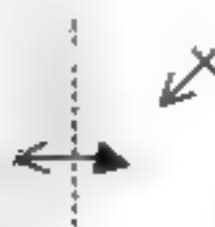
28. Reverse fold again.



29. Reverse fold asymmetrically. Repeat behind.



30. Crimp fold the tail while simultaneously pushing half of the middle of the tail inside out.



31. Fold and unfold the flap not quite halfway. Repeat behind.



32. Sink the two areas triangularly



33. Reverse fold. Note that the crease does not go point to point.



34. Outside reverse fold.



35. Pull out two small hidden flaps



36. Outside reverse fold the horn from the center of the head. Be very careful, it is easy to tear off the horn at this point. You may need to use a paper clip or tweezers.



37. Thin the horn further by sinking it in half.



38. Crimp fold the ear. Repeat behind.



39. Complete the ear by folding the flap back to turn a point. Repeat behind.



40. Outside reverse fold the tip of the nose.



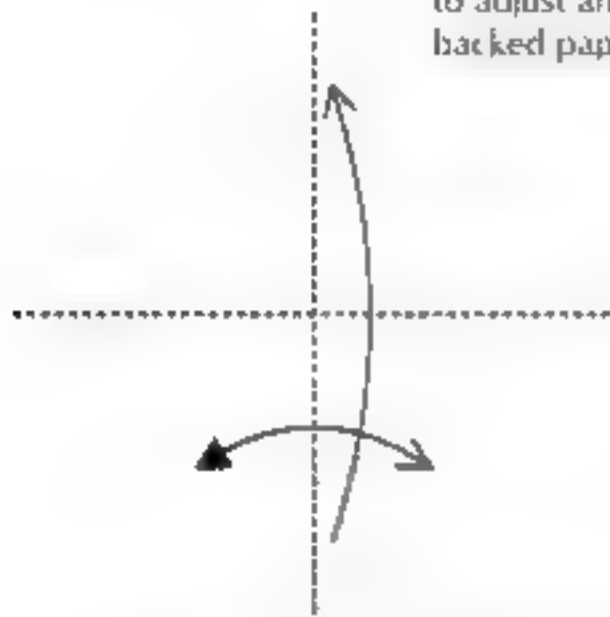
41. Reverse fold the nose again.

42. To complete the model, press the body and horn to make them 3D.

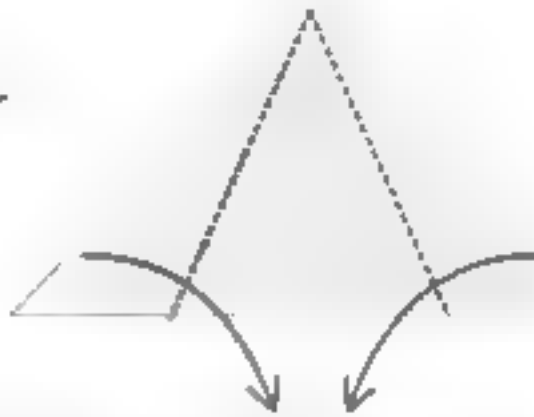


## Squirrel on a Log - Patricia Crawford

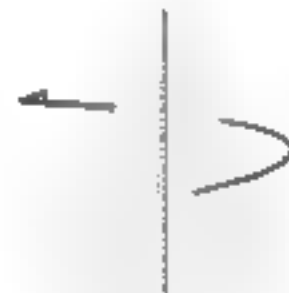
This is another wonderful model by Patricia Crawford from my first origami book. It is not as difficult to fold as complex models go, but it does contain many subtle folds, like those that make up the squirrel's face and the arms of the tree. In the original diagrams, many of the folds were not well marked, and I have done my best to represent the model here as well as I could, but you may need to adjust and sculpt as you go. The model should be folded from foil or foil backed paper. A 10" piece of paper produces a model approximately 5" long.



1. Fold and unfold the paper in half along one diagonal, then fold and leave folded along the other diagonal.



2. Very carefully fold the corners downward.



3. Fold the model in half.



4. Reverse fold the point. The ends of the crease are located halfway along the side on which they lie.



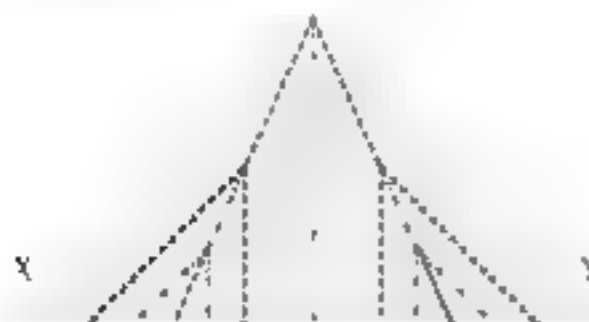
5. Fold the flap down. Repeat behind.



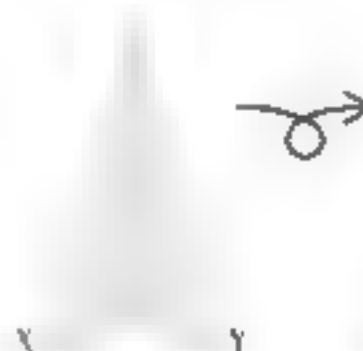
6. Fold the flap up. Repeat behind.



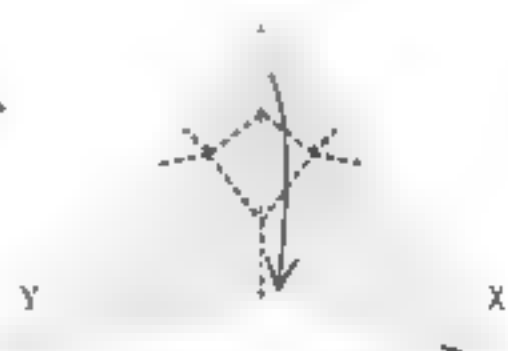
7. Unfold to step 2.



8. Assemble along the indicated creases, most will already be in the proper orientation.



9. Like this. Turn the model over.



10. Open the model slightly and fold back a single layer as indicated and close up the rest of the model on the existing creases. Note that the top triangle of the valley folded diamond is smaller than the bottom one.



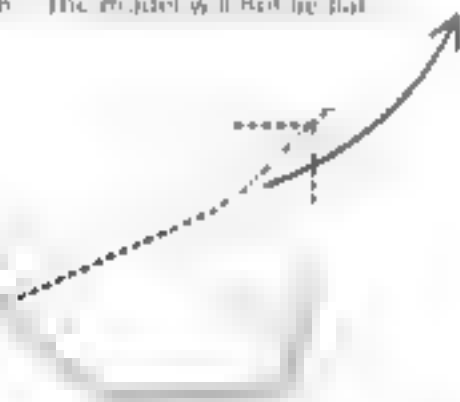
Tuck the flap inside. Repeat behind.



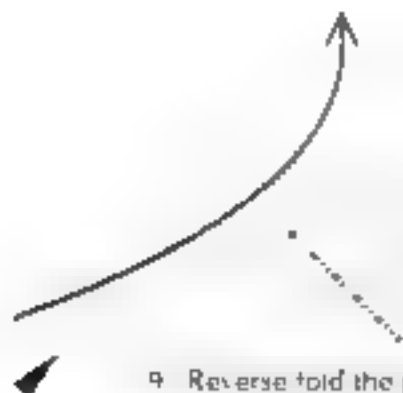
13 Fold and unfold



5. This is a partial view of the model. Carefully pull up the flap to open the point. The model will not be flat.



17. Close the flap back up, incorporating an extra reverse fold on the head. Note that the reverse fold is not flush with the the folded edge.



9 Reverse fold the point upward.



12 Sink the flap 1/3 triangularly



14 Execute a difficult crimp fold, sinking the area inside as you execute it. The inside needn't be open by the outside should be.



16 Open the flaps to the side as you add the flap down.



18 Sink the two regions, one in front and one behind. Be careful not to let the nose move out of position. This is trickier than it looks, if done correctly.



20 Reverse fold the point again



21 Shape the ears and the top of the head with two earflap sinks. Reverse fold the nose.



22 Complete the ears by spreading them open on either side. Note that the ears will be connected on the back. Complete the head by folding the flaps on either side inside.



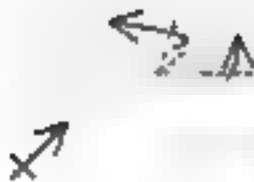
23 Complete the neck by folding two more flaps inside the model.



24. Squash fold the flap. Repeat behind.



25. Pleat fold the flap. Repeat behind.



26 Swivel fold the leg. Repeat behind.



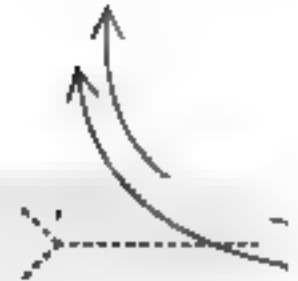
27 Tuck the flap at the rear of the leg under the flap that makes up the body. Repeat behind.



28. Pull out the top layer of paper turn the indicated point inside out, and reassemble on the existing creases. This is similar to a wrap. Repeat behind.



29. Fold the flap in half using a swivel fold. Repeat behind.



30. Fold the branches into place with two rabbit ears.



31. Execute two reverse folds.



32. Execute two more reverse folds.



33. Turn the rear branch inside out.



34. Fold the flaps inside.



35. Sink the two long points in angularly.



36. Create back legs with small crimp folds in front and behind, and by crimping the tail upward.



37 Crimp the tail and open it out into a bush by pulling the sides down and pushing the center upward.



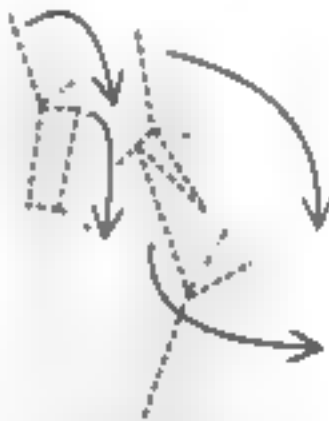
38 Tuck the large flap inside



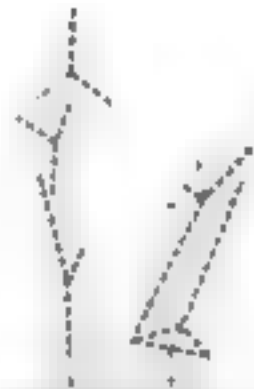
39 The next several steps are sculpting to complete the branches of the tree. Reverse fold the top of one branch, twist the other in half.



40 This is a close up view of just the branches. Pull out some paper from behind the right branch.



41 All of these folds are variations of rabbit ears.



42 Complete the model by rounding out the log by inserting a pencil in the front of the model between the first and second of the four layers of paper.

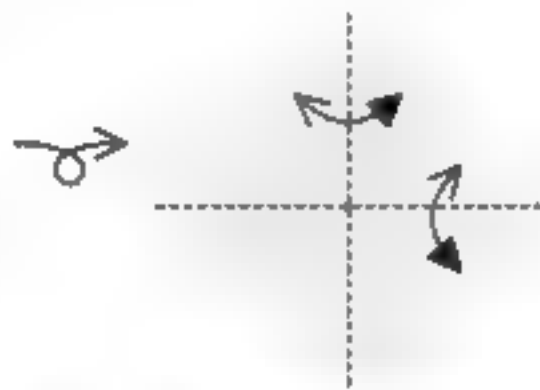
# Full Rigged Ship Patricia Crawford

## Base & Stand - Fred Rohm

This model is not as difficult as it looks, but it looks so hard that I never tried it until I was an adult. Once you get past the construction in step seven, the rest is straightforward. Patricia Crawford told me that Fred Rohm sent her the base for this model because he had discovered it but couldn't make anything interesting from it. She had been intrigued with the idea of creating a ship and realized the base was perfect. The next day she sent him the completed model, having created it in a single night. He later created the base & stand. I added the locking steps to the base while diagramming. The model should be made from fold or full backed paper. A 10" piece of paper produces a model 3 3/4" long. Fold the base from a piece of paper 1/9 the size of the paper you use for the ship, i.e. use a 3" piece of paper for the base if you use a 9" piece of paper for the ship.



1. Fold and unfold in both directions. Turn the paper over.



2. Fold and unfold in the other directions. Turn the paper over.



3. Bring all four corners together, forming a preliminary base on the existing creases.



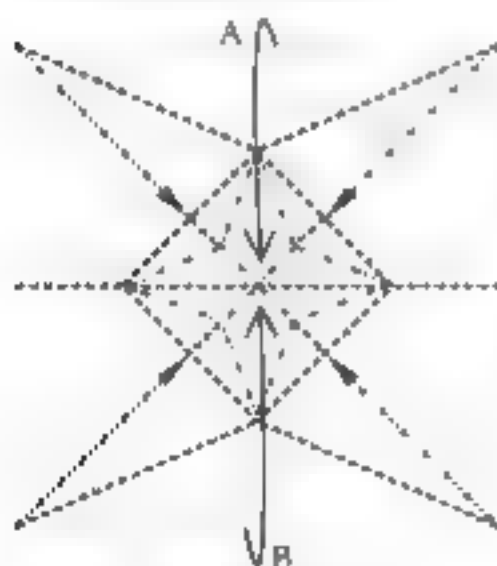
4. Petal fold upward and back down in front and behind.



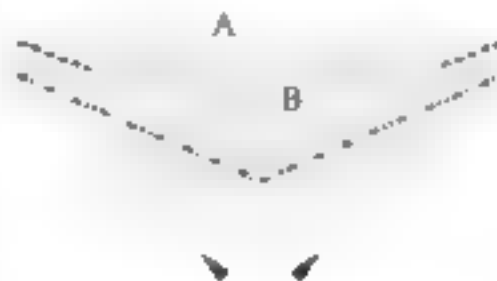
5. Fold and unfold.



6. Unfold the model completely.



7. Execute the construction by indenting the paper at the four indicated locations and bringing A to B.



8. Reverse fold the two flaps.



10. Sink the point.



11. Fold one flap up in front and one behind.



13. Fold one flap in front to the left, and one flap behind to the right.



15. Fold one flap in front to the left, and one flap behind to the right.



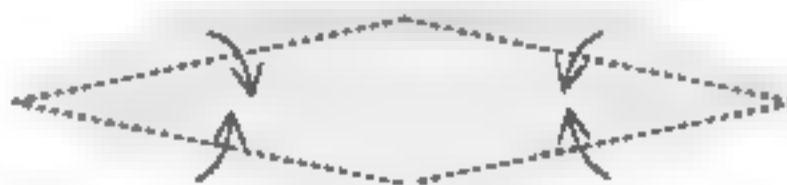
17. Execute a wrap on the upper region to turn the area white. Pull out part of the loose paper and fold upward to change the two bottom regions to white.



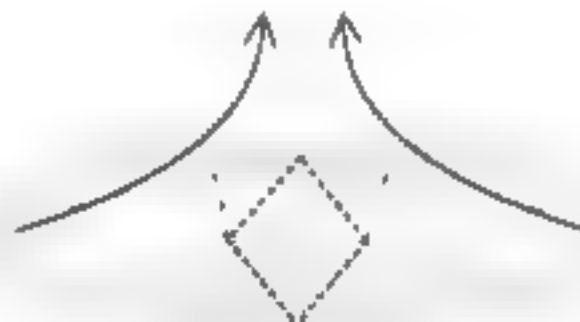
12. Closed sink the two points.



14. Closed sink the two points.



16. fold the four flaps inward



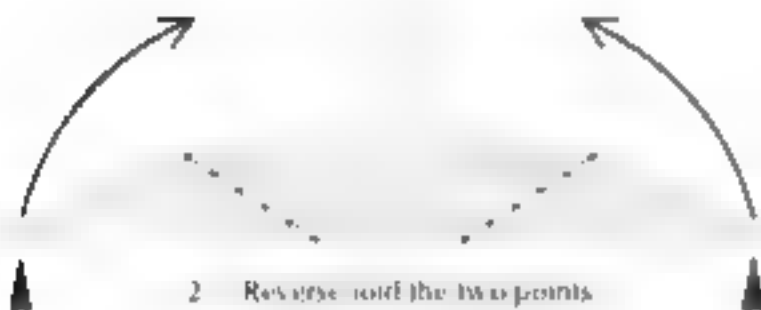
18. Rabbit ear the two flaps upward.



19 Tuck the white triangular area under the coloured layer



20 Fold the coloured area in half.



21 Reverse fold the two points



22 Reverse fold the point asymmetrically



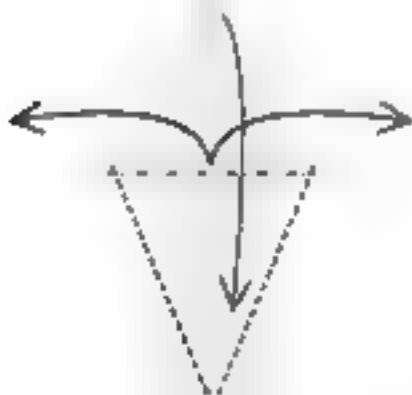
23 Execute a double rabbit ear on the coloured flaps to move the front sail into position



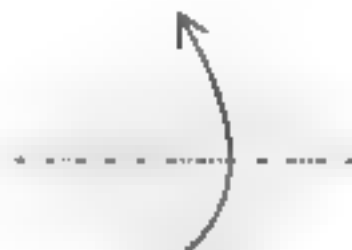
24 Tuck the flap underneath one layer of paper. Repeat behind



25 Fold the flaps inside



26 This is a detail illustration of the rear of the model viewed from the front. Fold the point down while spreading the edges.



27 Fold the flap up.



28 Fold and unfold





29 Fold the points twice



30 Crimp the tip.



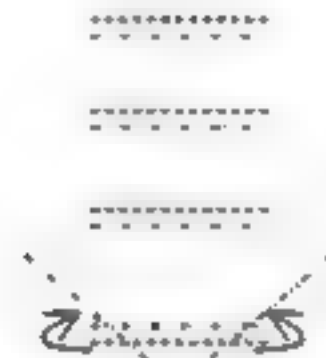
31 Fold the flaps behind and then the tip of the sail so that it is thinner than the lower portion.



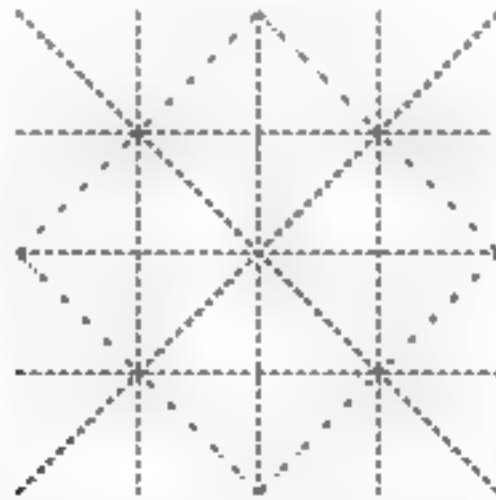
32 Bring the sail down into place, tucking in two tabs on the sides between the layers of hull, tuck the ship and rounding the sail as you fold.



33 Flatten the front and rear masts. The rear mast should have three thicknesses of paper on one side and one thickness on the other so there is an unbroken plane of white paper on the front of each mast.

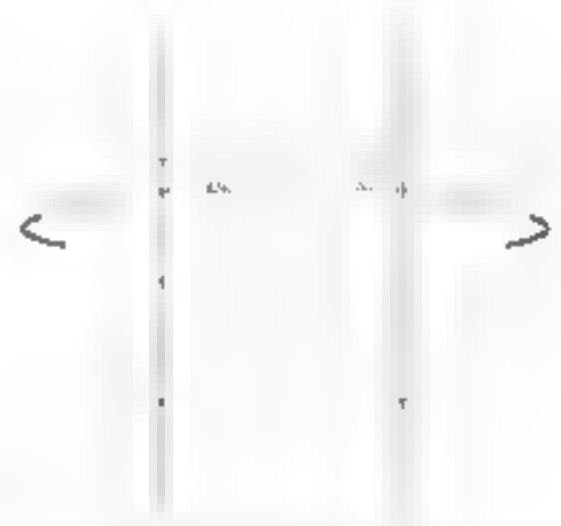


34 Create the sails on each mast with our crimp fold, three to one, three to one, then crimp it with one place with mountain fold on other side at the base of each mast.



35 Completed Ship.

36 To create the stand, start with a piece of paper 1/9 the size of the ship, and precrease to form a windmill base.



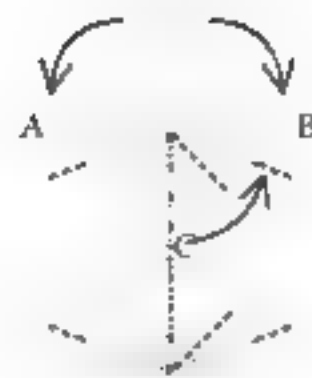
37 Fold the edges behind



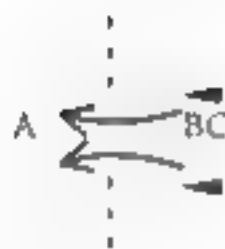
38. Petal fold the two flaps inward.



39. Make the indicated creases.



40. Bring the crease made in the previous step to the center while simultaneously swinging the center point upward and to the right. This will cause the upper points to spread apart. Repeat on the bottom.



41. Reverse fold the two flaps inside.



42. To lock the sides in place, valley fold the hidden flaps downward.



43. Complete the lock by mount and folding the two flaps underneath.



44. Reverse fold the sides inward.



45. Complete the base by flipping the ends backward and opening the four points slightly.

46. Completed model with attached stand.

# Kangaroo - Patricia Crawford

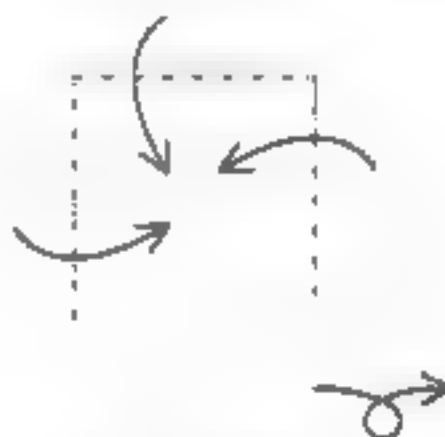
This is one of the most difficult models that I know, and in many ways, one of the most elegant. The initial construction is a real bear, but once you get past it, the remainder of the model is implemented with great efficiency. In the genre of origami, models of kangaroos with and without tails are surprisingly common, but this is the earliest that I know of, and remains my favorite. The model can be folded from any type of paper, but thicker papers generally work better if they have a tail backing. It also makes a challenging miniature. Try folding it from 3" Japanese toli. A 10" sheet of paper produces a model 3 1/4" in height.



1. Fold and unfold diagonally.

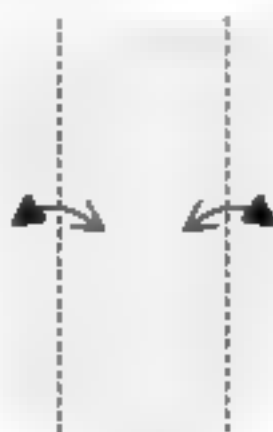


2. Fold and unfold diagonally, creasing only the center.

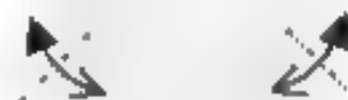


3. Fold three of the corners inward. Turn the model over.

*Note: For the next several steps, to clarify relationships, crease markings will be shown with lines which go from point to point, instead of the shortened lines which are normally used. It is also assumed that while precreasing, the paper is turned over for mountain folds.*



4. Fold and unfold in quarters.



5. These line up with the raw edge on the back.



6. Landmark these lines by folding the corners to the center.



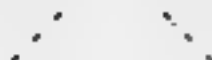
7. Fold the edge to meet the creased points.



8. Line the folded edge up with the horizontal crease.



9. Use the diagonals on the other side and the previous creases to landmark this fold.



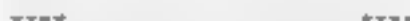
10. Use the lower points and vertical and horizontal creases as landmarks.



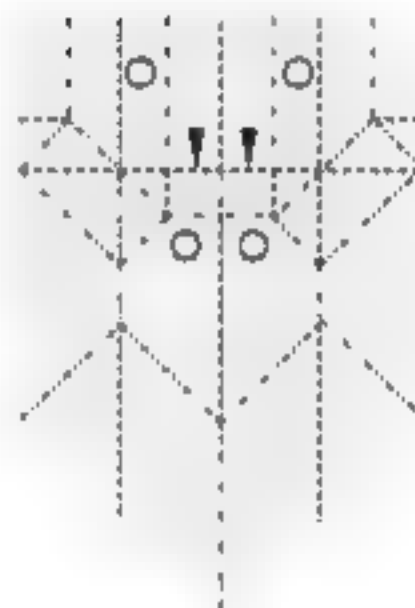
11. This line is halfway along the vertical edge.



2. Fold and unfold



13. Fold and unfold



14. The most important fold in this construction is the complex swivel fold that occurs in the center of the model. Place each of your thumbs on the lower points, and your index fingers on the upper points, and push the central ridge upward while pressing the sides inward. If your model is well creased, the rest of the folds should follow naturally. Be patient. The first time I executed this step it took me over twenty minutes.



5. This is an intermediary view of the construction.



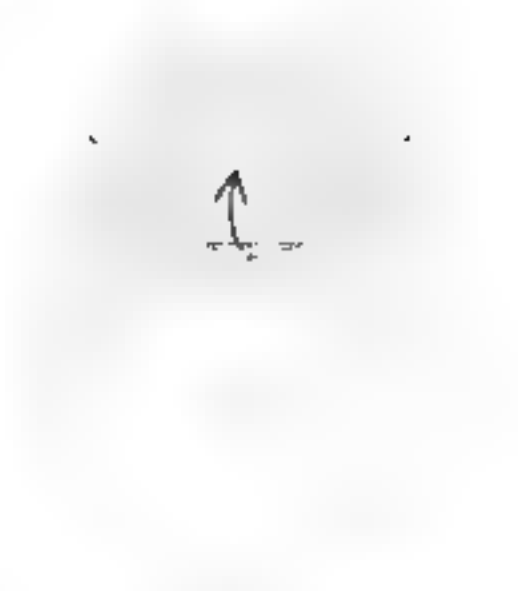
16. The construction is now complete. Pull open the bottom to incorporate more creases.



17. Pull out the hidden flap.



18. Fold the tip underneath.



19. Pinch the tip together and push upward. The mountain folds are angle inspectors. The flap will not be flat but will flatten when you close the model back up.



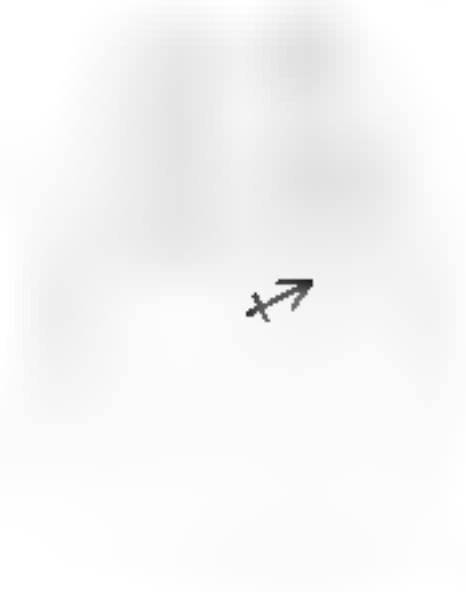
20. Pull out some loose paper.



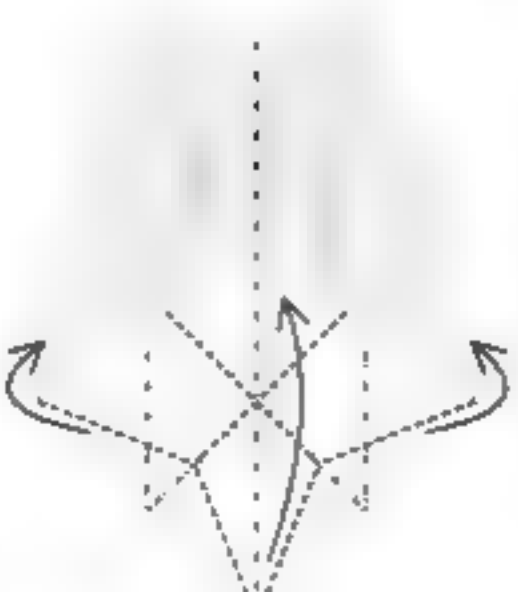
21. Fold the flap underneath.



22. This fold is an inside out rabbit ear and creates one of the joey's ears. Be careful to keep the underlying layer in place as you fold.



23. Repeat steps 40-42 on the other side.



24. Now, carefully close the model, putting the loose paper around the joey's ears back into position as well as possible, and incorporate the extra creases at the bottom. To do this pre-crease each of the folds as indicated, then swing the side flaps backward and the lower point upward. The rest of the folds will follow naturally.

25. Reverse fold the tail

26. To complete the join, push the two extra flaps inside the model. It may be necessary to gently pull the ears or head outward to adjust them to the right size.

27. Crimp fold the tail backward. Point C will meet line AB.



28. Thin the tail by folding the flap up, repeat behind.



29. Fold and unfold one thickness.



30. Precrease two more lines.



31. Swing point A to B, incorporating the creases. This is similar to a double swivel fold.



32. Repeat steps 49-51 on the other side.



33. Reverse fold the flap. Repeat behind.



34. Hide the tips with two reverse folds. Repeat behind.



35. Fold the two flaps inside.



36. Push the white area inside.



37. Outside reverse fold the tip of the tail. Crimp fold the feet.

38. Reverse fold the four points.

39. Sink the second and fourth of the five points. The dotted lines show the correct final position of the sinks.



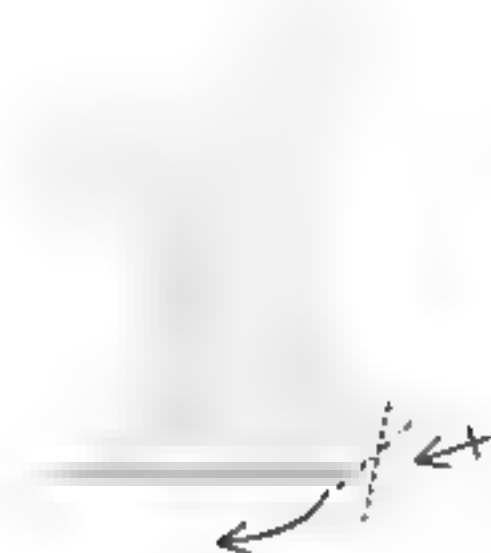
40. Fold the flap down. Repeat behind.



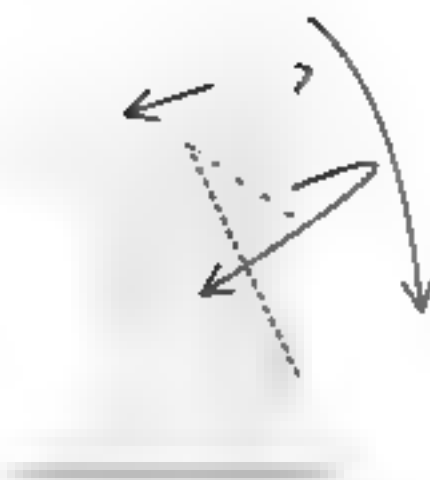
41. Fold the flap to the left. Repeat behind.



42. Crimp the arm upward. Repeat behind.



43. Make a paw by crimping the ends of the arm. Repeat behind.



44. Squash the nose so that the edges each wrap around the outside of the head.



45. Reverse fold the tip of the nose



46. Reverse fold again.



47. Rabbit fold each of the ears. Note that this fold does not meet the top of the ear.



48. Thin the neck by folding the four separate thicknesses inside.



49. Complete the model by rounding it out and making it 3D.



50. Completed model.







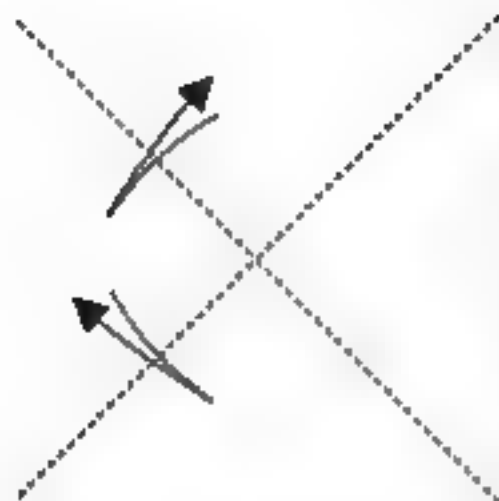
# Creations

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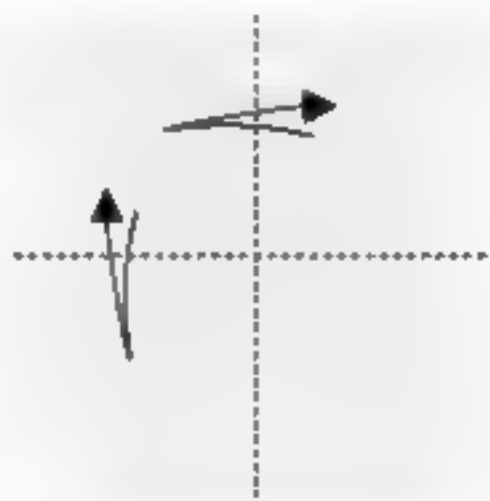
*"Art is not in pictures alone. Its place is in everything"*

*— Robert Henri*

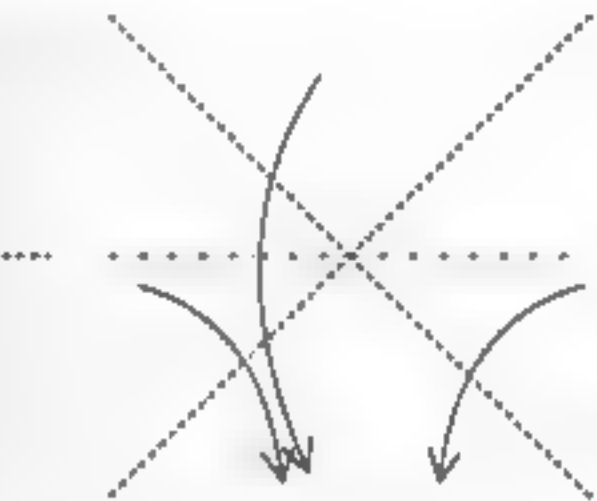
**Horseshoe Crab** - This was the first original model that I ever created. It was made by accident when I was experimenting with trying to create the dragonfly. Structurally it is very simple, formed mostly with squash folds, petal folds, and reverse folds. When I created it I was not sure if I was a bug or a horseshoe crab, so I took a poll. The horseshoe crab won. The model can be folded from any paper, but foil works best. A 10" piece of paper produces a model approximately 3" in diameter.



1. Fold and unfold diagonally.



2. Fold and unfold laterally.



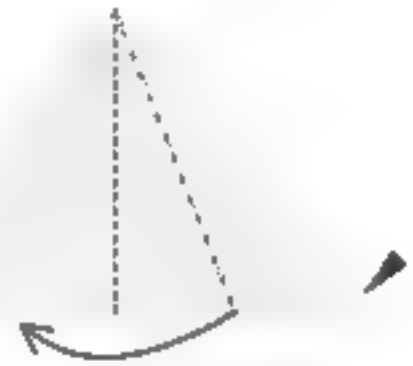
3. Fold a waterfall base on the existing tracks.



4. Fold one flap in front to the left, and one flap in back to the right, to make sure that the model is completely symmetrical.



5. Fold and unfold the flap.



6. Squash fold the flap.



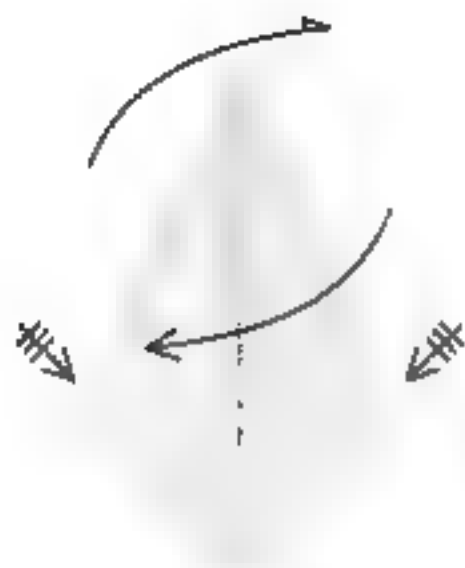
\* Repeat the last two steps behind.



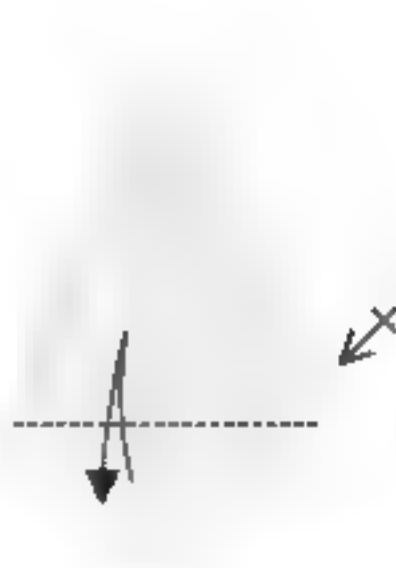
8. Fold one flap from left to right. Repeat behind.



9. Repeat the squash folds on the remaining two flaps.



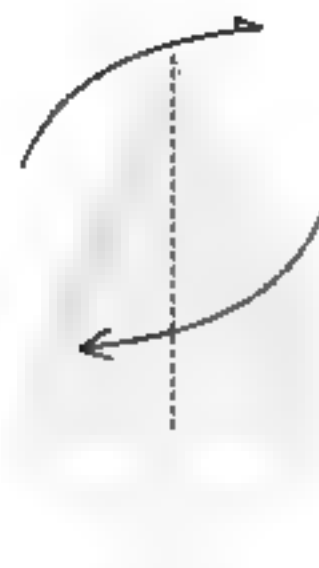
10. As in step 4, rotate all 4 flaps, one at a time, one in front then one in back, to assure symmetry.



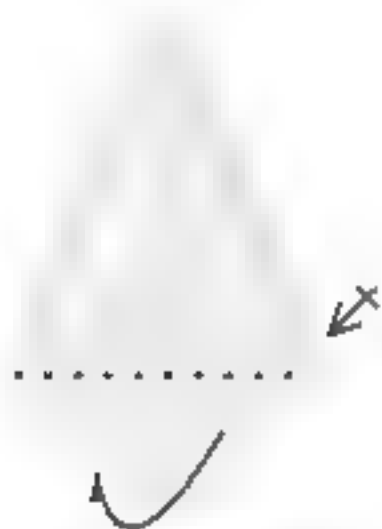
11. Fold and unfold. Repeat behind.



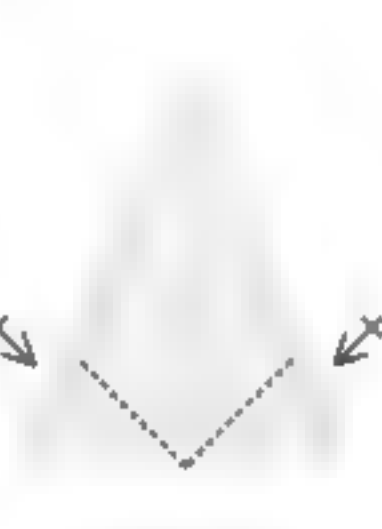
12. Fold the flap inside the model being careful not to lock the other two flaps inside. Repeat behind.



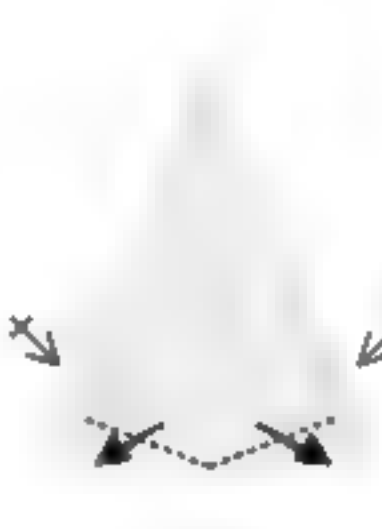
13. Fold two flaps in front to the left and two flaps in back to the right.



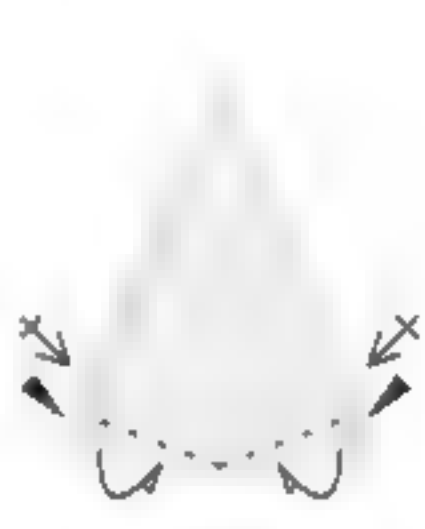
14. Fold the flap inside. Repeat behind.



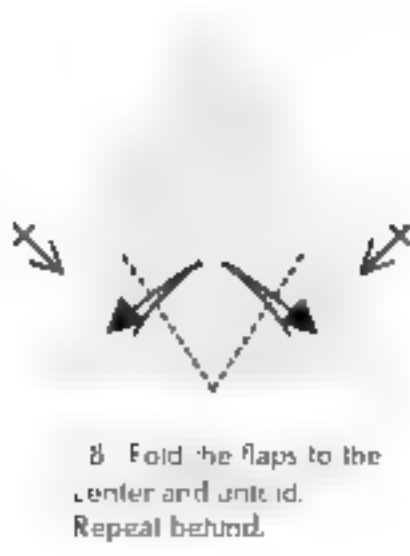
15. Fold and unfold. Repeat behind.



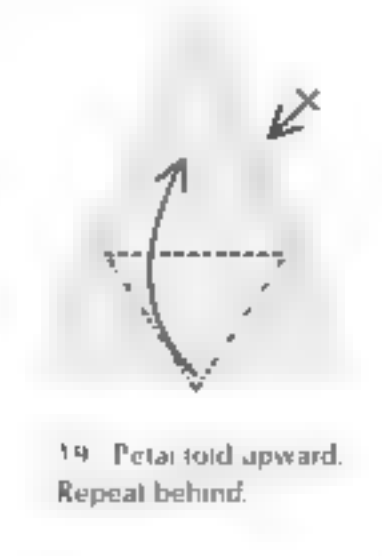
16. Fold and unfold. Repeat behind.



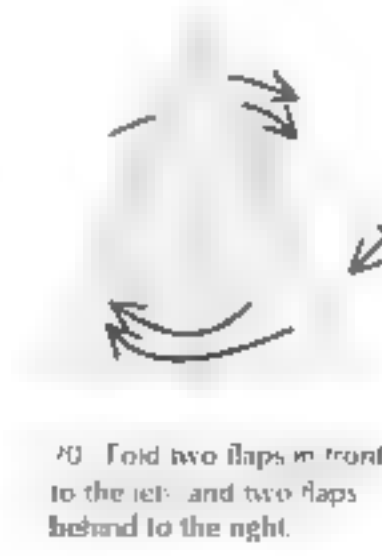
17. Reverse fold the flaps inside. Repeat behind.



18. Fold the flaps to the center and unfold. Repeat behind.



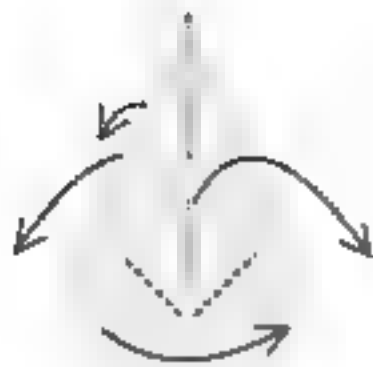
19. Petal fold upward. Repeat behind.



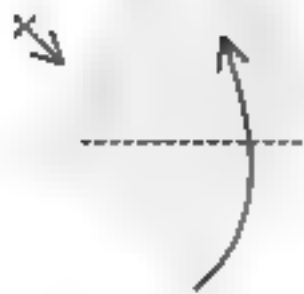
20. Fold two flaps in front to the left and two flaps behind to the right.



21. Repeat steps 15-20



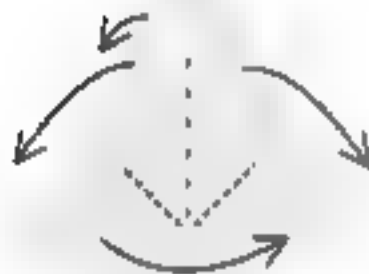
22. Fold one flap to the right, reverse folding as you go, repeat behind, so that the legs are on opposite sides. The right leg will be raised, the left leg will be lowered



23. Fold the flap up, repeat behind



24. Repeat step 22 placing both legs on the same level



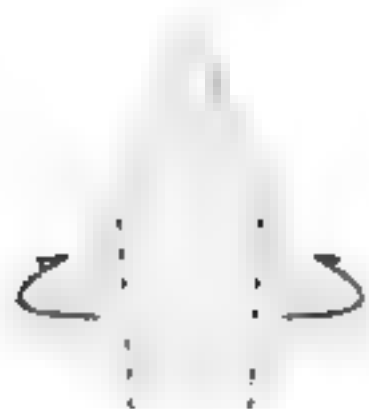
25. Repeat for the final set of legs placing the right leg lower and the left leg higher



26. Turn each of the six legs by executing two reverse folds on the outside of each leg.



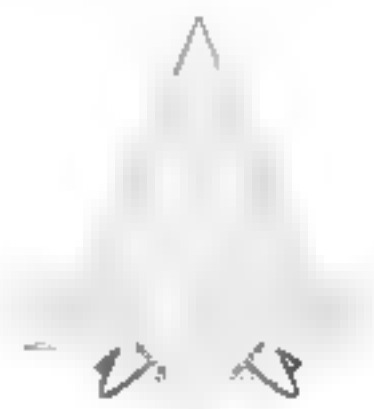
27. Fold the flap inside, as far as it will go



28. Fold the flaps inside. Note that the line is just slightly off parallel from the center



29. Fold the flap underneath.



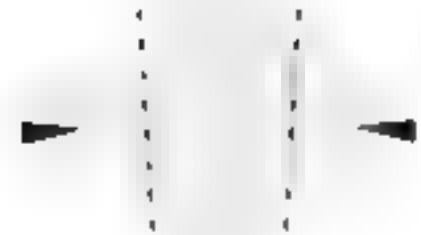
30. Fold the corners underneath



31. Fold the two flaps on each side of the model by making or tucking them inside



32. Turn the model over



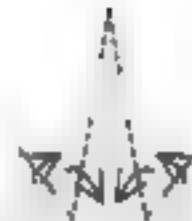
33. Sink in to k the flaps inside, as in step 31



32. Fold the flap up as far as it will go



33. Crimp fold the tail



34. Turn the tail with two swivel folds.



35. Fold the last two corners in and turn the tail further by pinching it in half. Turn the model over

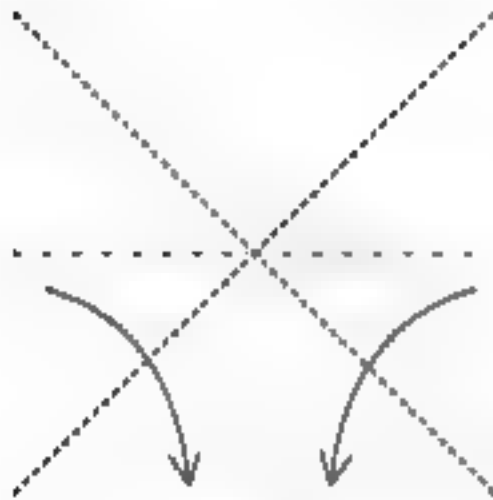


36. Complete the model by curling the legs backwards



37. Completed model

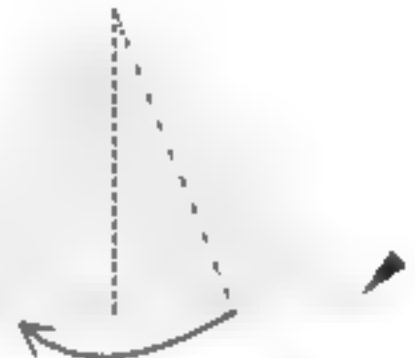
**Wolf Spider** - This was the first complex model I created on my own. I discovered the first version by accident while working on the "Dragonfly". But there were several problems with its proportions: the thorax was too small, and the legs were different lengths. The model as it exists is rather difficult to fold, but with practice it gets easier. The media choice is very important. I recommend a soft, foil backed paper such as tissue or handmade cheyogami. Japanese foil also works well, but American foil is too thick. A 10" piece of paper produces a model 4" across. The model also folds well in miniature, try folding it from a piece of paper 4" or smaller.



1. Start by folding a waterbomb base, coloured side out.



2. Fold and unfold the flap.



3. Squash the flap.



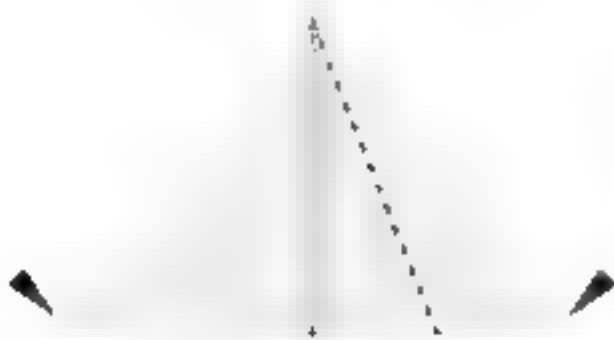
4. Turn the model over.



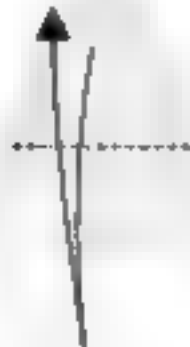
5. Repeat the squash fold.



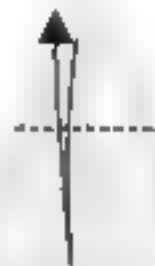
6. Fold one flap from left to right in front and behind.



7. Repeat steps 2-6 on the remaining two flaps in front and behind.



8. Fold in half and unfold.



9. Fold the tip down to the edge of the paper and unfold.





10. Fold the second crease down to the first crease and unfold.



11. Execute a crimp sink on the two lower creases. A detailed description of this procedure can be found in the "Bases" section.



12. This is a completed spider base, raised configuration.



13. Find and unfold all layers of the flap.



14. Pinch the flap where indicated and squash, flattening where the lines indicate but not flattening the flap that you are pinching. The model will not lie flat.

15. Now, bring the flap back, keeping the squashed area flat, and pulling the raised area back into its previous position. An annoying third ridge of paper will appear between the two ridges (shown as AB in the following step) as you do this. Adjust the third ridge so that it matches the line shown in the following illustration, sticking a finger inside the model and guiding it as you fold.



16. Completed squash. The dotted lines indicate an X-ray view of the hidden ridge and accompanying structures. Repeat steps 13-15 on the other seven flaps.



17. Sink the 32 sided area at the top about one half the way down from the top. The inside needn't be perfect, but the outside should be



18. Fan open the sink, pulling the ridge down all the way around. This is like making the bottom of a hat. The fold needn't be perfect, it's done to make subsequent steps simpler.



19. Prepare to double petal fold. Fold flaps in and unfold.



20. Petal fold.



21. Preparing for the second petal fold. Fold and unfold.



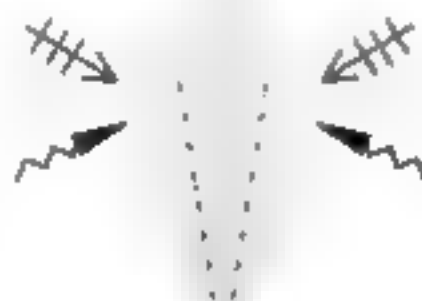
B

22. Now we will execute the second petal fold. This is very messy. Place a finger where indicated to anchor the model. Gently pull point A all the way down B, keeping in mind that you are trying to create a horizontal crease. As this will cause the paper outside the 'horn' to move downward. The model will not be flat. Once point A is in place, go to work, mounding and gently pulling in the paper to form the other lines of the petal fold: first the lower diagonals, then the upper diagonals. Be very careful to assure that the multiple layers of paper stay in place as you do this. This procedure is very difficult at first, but becomes easier once you get a conceptual understanding of what you are doing.



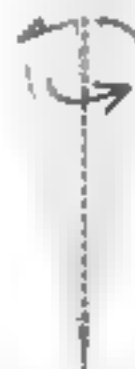
AB

23. The second petal fold is complete. Repeat steps 19-21 on the remaining three sides. As you do this you will be constantly moving the 'horn' paper at top as it your way and adjust as needed. You will be opening it out and readjusting. (Step 24)

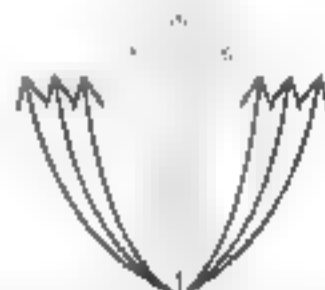


24. Insert your index finger up inside the model and mold the 'horn' into shape by completely opening out the 'brim' of paper at the top.

25. Turn the legs by pleat sinking the eight flaps.



26. Fold one flap in front to the right and one flap behind to the left.



27. Reverse fold six legs into position. Adjust the legs so that the topmost legs are most forward, and the lower legs are most backward.

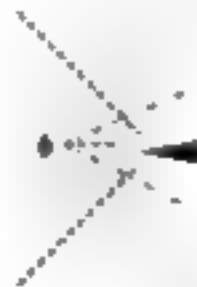


28. Notice how far back the legs are placed. Shape the body by folding the eight indicated flaps inside the model. Fold the top and bottom flaps into legs by folding the edges under and then pinching them in half.



29. Place the top front leg to the right, the lower leg to the left.

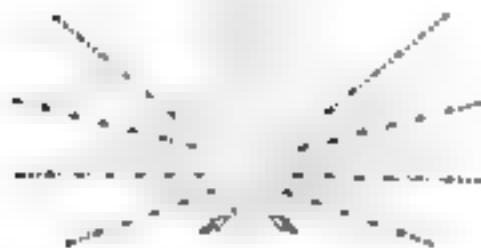
30. Tuck the legs inside the body just slightly to push them into final position.



31. The paper to create the pedipalps can be found between the second and third legs. Open the model between the second and third legs where indicated.

32. This is a simplified view showing only the space between legs two and three from the front of the model. Collapse the indicated edge of paper between the legs, and close the model back up, positioning the new point so that it protrudes out the front of the model.

33. Repeat steps 31-32 on the other side.



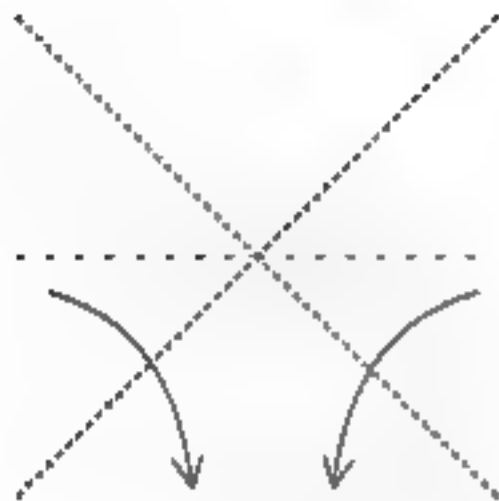
34. Pinch each of the legs in half, and pinch the pedipalps into a point. If necessary, reposition the front legs so that the pedipalps show.



35. To complete the model, curl the legs so that they lift the body off the table, and mold the side of the body to make the lines softer.

36. Completed model.

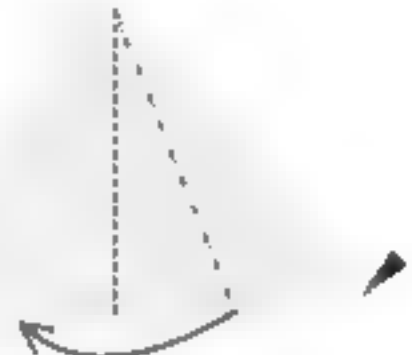
**Octopus** - This model was discovered completely by accident while I was developing the "Wolf Spider". After folding the first version I never bothered to document it. There were no diagrams at all, but conceptually the model is simple: fold a spider base, execute double petal folds, and thin each of the legs. It was not until nine months later when I actually diagrammed the model I discovered that it has the same proportions as the "Tarantula". It should be folded from foil backed paper. Gold Japanese foil works very well. A 10" piece of paper produces a model 4" across.



1. Start by folding a waterbomb base, colored side out.



2. Fold and unfold the flap.



3. Squash the flap.



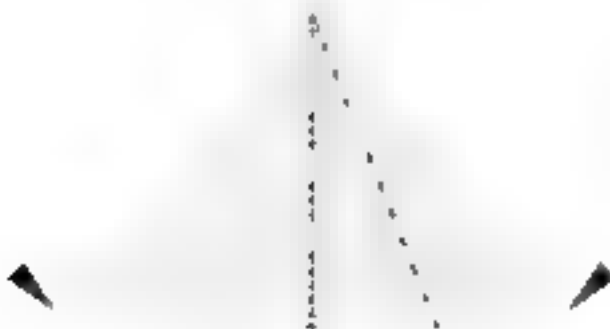
4. Turn the model over.



5. Repeat the squash fold.



6. Fold one flap from left to right in front and behind.



7. Repeat steps 2-6 on the remaining two flaps.



8. Fold in half and unfold.



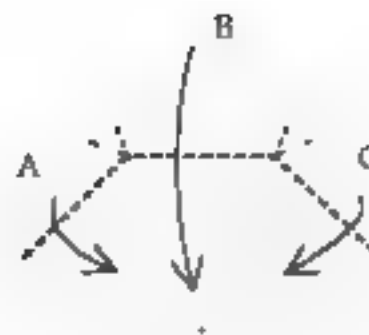
9. Fold the crease down to the edge of the paper and unfold.



10. Execute a crimp sink on the two creases. The following steps detail the procedure.

Location of first  
sink (underside)

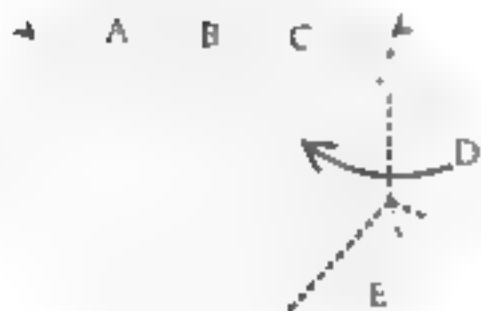
Location of second  
sink (underside)



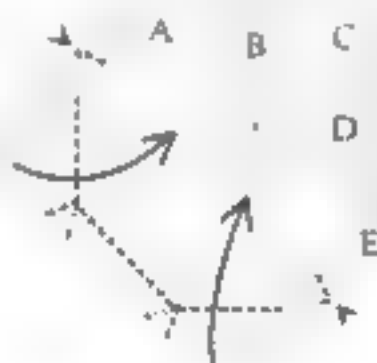
10a. Unfold the model completely.  
Note the locations of sinks to be  
executed. Turn the paper over

10b. Bring the three points in to the center  
on the existing creases, folding the sides first  
(A & C), and then the top (B). Don't worry  
about the lighter lines, just do the dark portions  
and the others will follow naturally

*Note: The creases on the sides will only come as far  
as the arrows indicate. The model is shown flat to  
clarify the folding procedure but is actually 3D.*

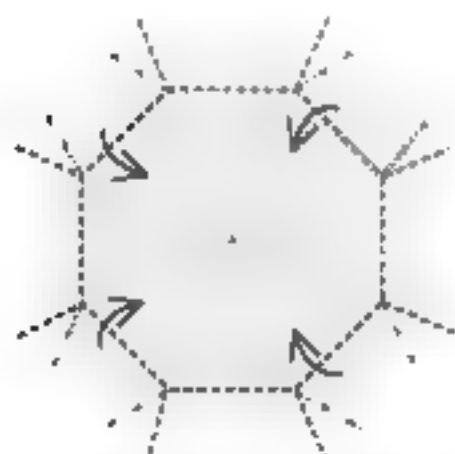


10c. Bring the next two points  
D & E to the center as in step 10b

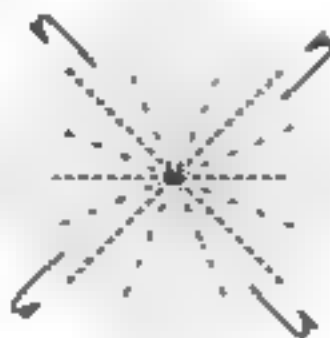


10d. Continue around the circle  
with the remaining points

10e. Turn the model over



10f. Repeat the process on the next  
layer of folds, letting the flaps swing  
out from behind.



10g. Now, to complete the sink, fold  
the model up like a fan on the  
existing creases.

11. This is a completed spider  
base, lowered configuration.



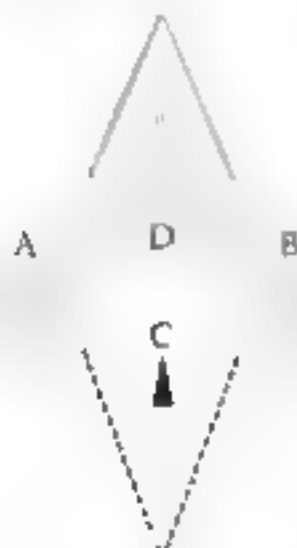
12. Preparing to petal fold – fold two layers upward, making a horizontal crease through only one layer and unfold. This crease will be very important later



13. Fold the sides in and unfold



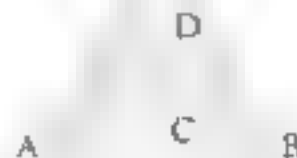
14. Fold the flap upward, forming two triangles which will pull the two sides in.



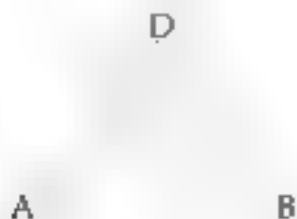
15. Starting the petal fold – grasp point D between thumb and forefinger and gently pull upward, then push point C inside out, forming a new lateral ridge along line AB (creased in the previous step) and creating a flat plane from line AB to point D. The side flaps will pull in naturally. The model will not lie flat!



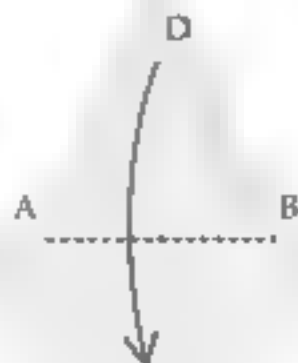
16. Continue the petal fold by making two straight lines on the back of flap ADB, one from point A to point D, and another from point B to D. There are no creases to guide you, it must be done by eye. As the fold is executed, you will have to form a pocket between the two ridges of paper, like the one you are forming, and the one you precreased in step 14



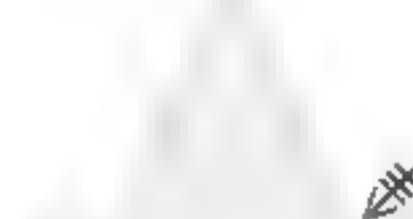
17. Complete the petal fold by continuing to flatten out the flap, readjusting the crease forming the upper ridge so that it lines up with the lower ridge, bringing D all the way up into place, and flattening out the model completely



18. This is an X-Ray view of the inside of the flap



19. The petal fold sequence is complete. Fold the flap down.



20. Repeat steps 12-19 on the back and sides.



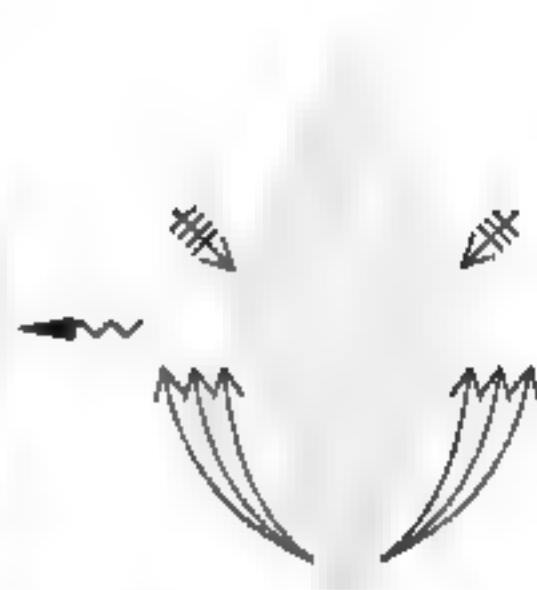
21 Crease the side flap by valley folding in half along the two vectors.



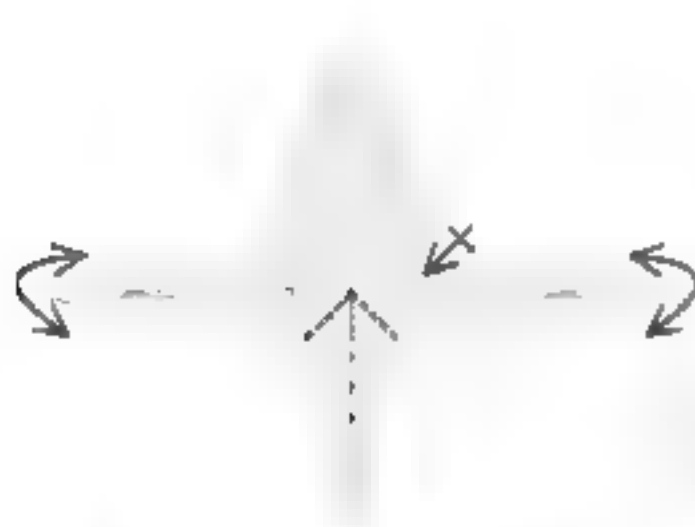
22 Unfold



23 Pleat sink the delta shaped area as if there were one continuous surface of paper.



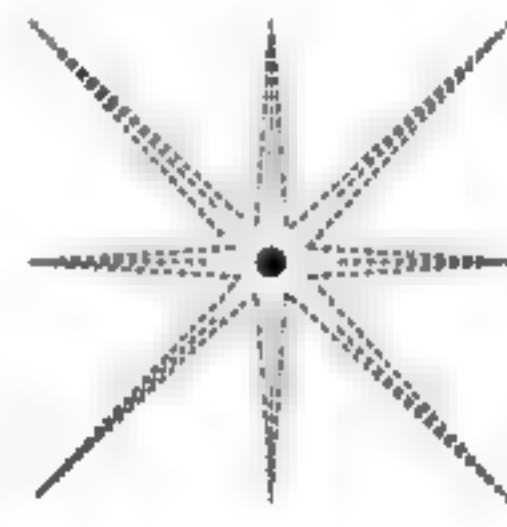
24 Repeat steps 21-23 on the other seven flaps, then reverse fold each of the three side flaps upward.



25 Note that all the legs are not the same length. Reverse and the last two legs by pinching the flaps together in front and behind. The other flaps will naturally fan out and the model will become 3D.



26 This is a 3D view of the model. Turn the model over to expose the bottom.



27 This is a bottom view of the model. This is done by opening it slightly, folding in the sides, and pinching it closed again.



28 We're almost done. To shape the top, wrap your thumb and forefinger around the base of the model where the arrows indicate. Insert a finger deep inside the hole in the bottom, and carefully mold into shape opening all the internal ridges completely and pinching the model slightly closed at the base.



29 To complete the model, tilt the body back slightly, and put gentle curls in each of the legs.



30 Completed model.

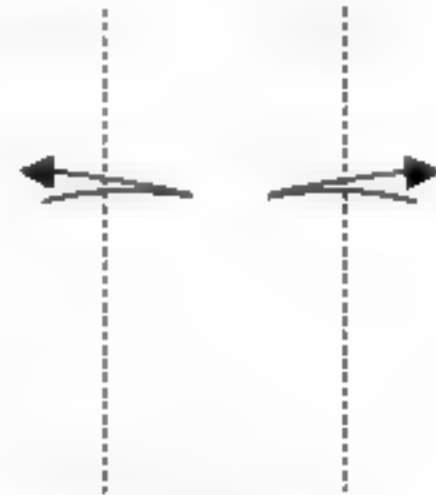
**Andrea's Rose** - Sink folds are often a stumbling block for folders as they move into intermediate models. But they are actually not that difficult, once one learns to execute them correctly. "Andrea's Rose" was designed to teach the proper method for executing open sinks, and with the exception of creating the windmill base, the model is composed entirely of sinks. As you fold the model, the sinks will actually get easier as they get smaller, because "practice makes perfect". The model can be folded from any type of paper, though foil is more difficult. A 10" piece of paper produces a 5" model.



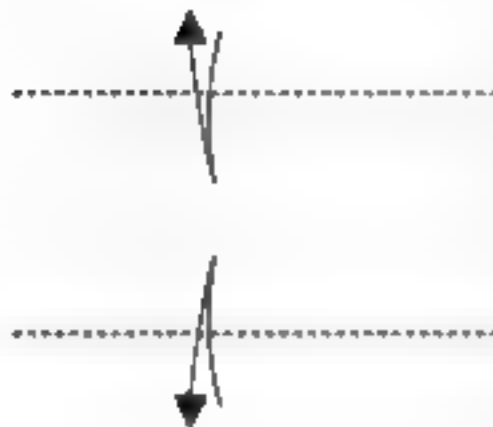
1. Fold and unfold.



2. Fold and unfold.



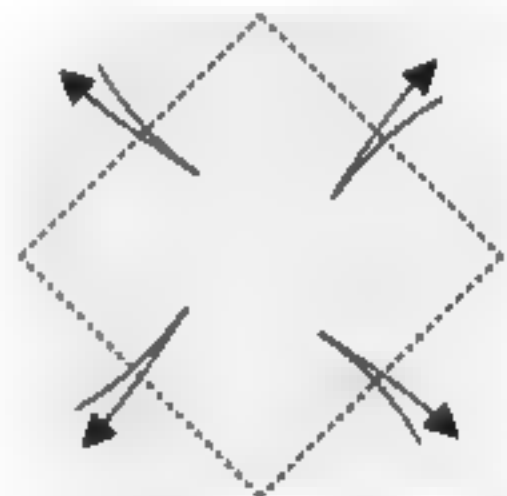
3. Fold and unfold.



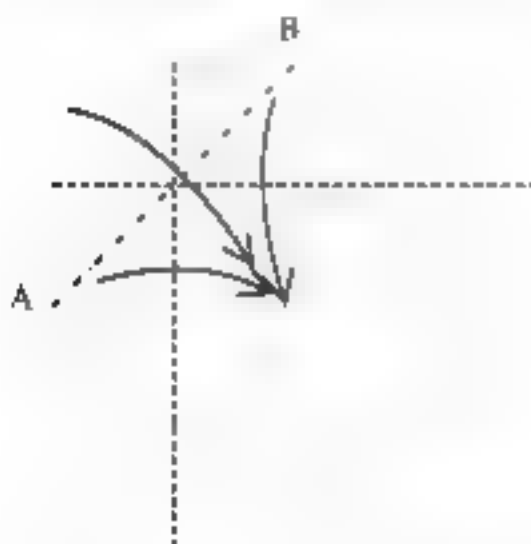
4. Fold and unfold, turn the paper over.



5. Like this.



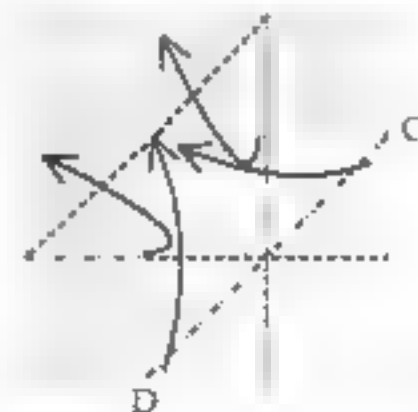
6. Fold and unfold all four corners. Turn the paper over.



7. Following the existing creases, bring points A and B to the center.

A B

8. This is a mid-fold view.



9. Repeat step 7 on C & D.



10. This is a completed Windmill base. Rotate the model 45 degrees.

11. Steps 11-13 show the correct way of executing an open sink on the top corner. When you are comfortable with the sequence, steps 13-15 will be executed as one step without flattening the model. If the sequence confuses you, see the additional explanation in the "Techniques" section. Fold all layers to the center.

12. Fold the layers back up.

13. Pull flap A all the way upward, opening out B & C.

14. Fold back up on the previous crease, but turn the three lines of the completely opened flap (shown bolded), inside out.

15. Complete the sink by folding point A back into place, pulling the side flaps inward as you go.



16. Fold the flap down.

*Note. Steps 19-22 show the correct way of executing an open sink on the top corner when there is no way of opening the model up. The method used is the spread squash method of sinking. On complicated models, this is often the simplest way of executing sinks. When folding up the squashes as in step 22, keep in mind that the finished product should look like a sink.*



17. The first sink is completed. Repeat steps 11-16 on the three other flaps. The folds will become more complicated as you go because you will not be able to open the model completely.

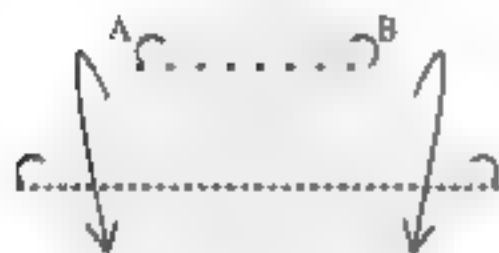
18. The first layer of sinks is completed. Turn the model over.



19. Fold a single thickness down.



20. Fold the flap back up.



21. Note the location of the four anchor points. Place your index fingers on the upper points, under two layers of paper, and your thumbs on the lower points, under just one layer of paper. Pull the entire flap downward, across the middle line, pushing on the center of the point with your third thumb. This will cause the entire point to spread-squash into a square located directly over the center of the model.



22. Notice that the square is located directly over the center of the model. This is very important! Fold the squashed paper back up on the existing creases, pulling one double layer from each side inward as you go, as in step 15.



23. Execute the sink on the next flap. Note the placement of your fingers.

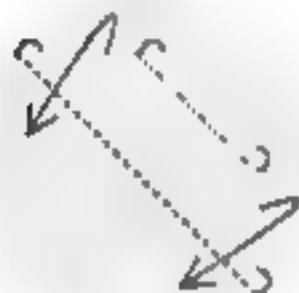


24. Remember when folding the sink back up, only bring in one layer from each side. It is an easy to grab two layers as one, and you can become lost easily if you aren't careful.

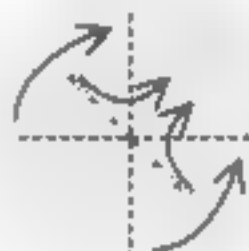


25. Repeat the sink on the two remaining corners.

26. At this point the model should be symmetrical in four directions, if it is not, then a mistake was made in folding up the sinks. If this is the case you must rearrange the flaps or the next level will not work. If all else fails, unfold the model and try again on the same piece of paper. It's always much easier the second time!



27. Continue sinking on the next level just as with steps 21-26.



28. Note that the squashed square is always directly over the center of the model. Fold the squashed area up as before.



29. Complete the level by sinking the other 3 corners.



30. At this point three levels of sinks have been completed. Keep adding levels until your eyes explode, your paper shreds irrecoverably, or you feel satisfied by the process. As a challenge, I try executing eight levels on an 8" piece of paper.

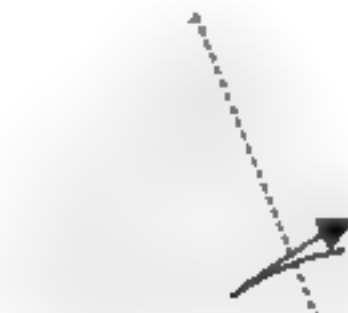


31. To complete the model, instead of sinking, valley fold the last set of flaps toward the center. Also pull out the flaps from behind.

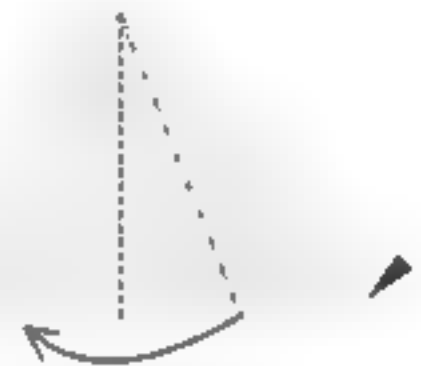
32. Completed model.

**Tarantula** - This is one of my favorite models. I created it accidentally when I was trying to fix some problems with the proportions of the "Wolf Spider". The first model had only six legs and pedipalps. To add the missing legs, simply started from a five sided waterbomb base. While researching the model I learned that there is no single spider called a tarantula, but that "tarantula" is actually a generic term like "dog" which refers to a number of very large hairy spiders. The model should be folded from foil backed paper. A model folded from a 10" sheet of paper will be 2" across. A model folded from a 10" cheater base will be 3 1/2" across.

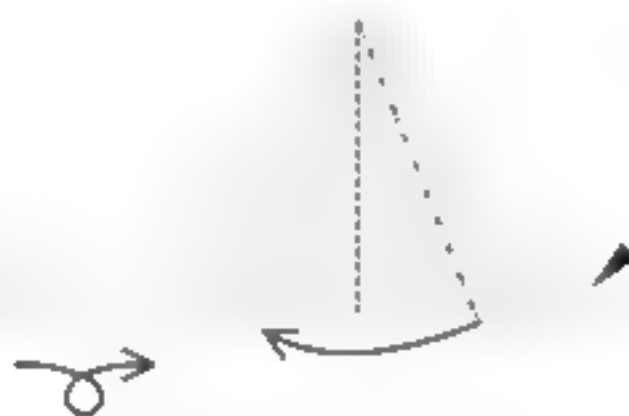
This model starts with a five sided waterbomb base, either the folded or cheater type will work. Directions for both types can be found in the 'Bases' section. If you have never folded the model before it is strongly recommended that that you use a cheater, as there are some very nasty sinks and molding steps that are hard enough to execute without having to worry about keeping track of which layers are part of the base and which are part of the model itself.



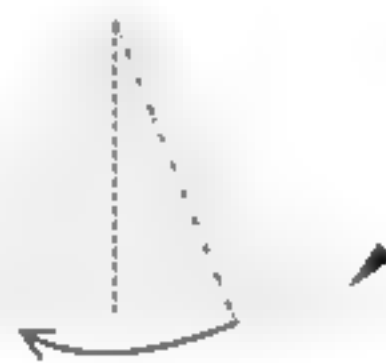
2. Fold and unfold the flap



3. Squash the flap.



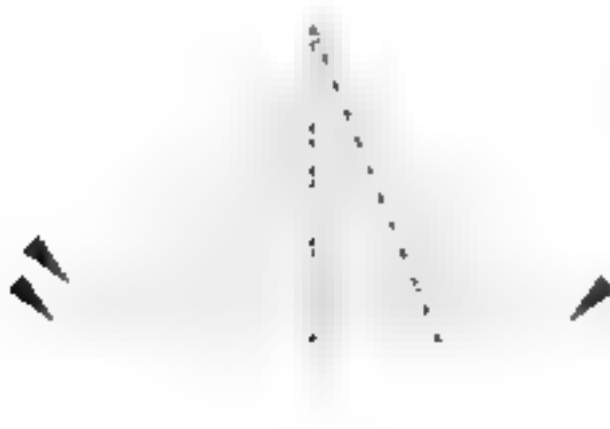
4. Turn the model over



5. Repeat the squash fold.



6. Fold one flap from left to right in front and behind



7. Repeat steps 2-6 on the remaining three flaps.



8. Fold in half and unfold.



9. Fold the crease down to the edge of the paper and unfold.

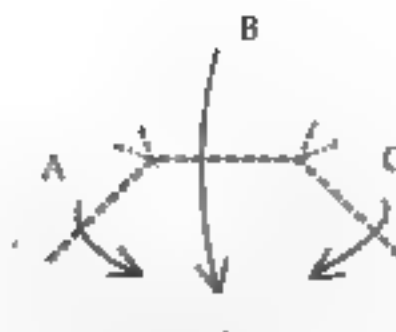


10. Execute a crimp sink on the two creases. The following steps detail the procedure

*Location of first  
sink (inward)*



*Location of second  
sink (outward)*



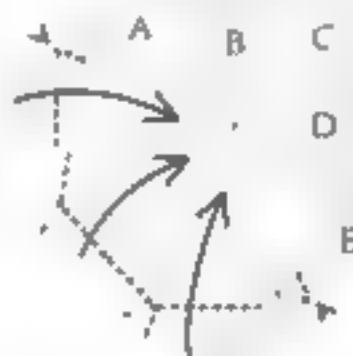
10a. Unfold the model completely.  
Note the locations of sinks to be  
executed. Turn the paper over.

10b. Bring the three points in to the center  
on the existing creases, folding the sides first  
(A & C), and then the top (B). Don't worry  
about the lighter lines, just do the dark portions  
and the others will follow naturally.

*Note: The creases on the sides will only come as far  
as the arrows indicate. The model is shown flat to  
clarify the folding procedure but is actually 3D.*



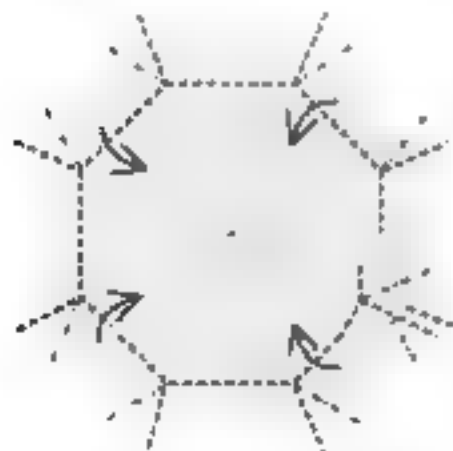
10c. Bring the next two points  
D & E to the center as in step 10b.



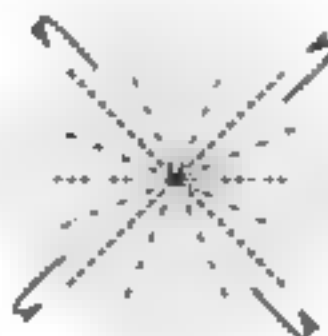
10d. Continue around the circle  
with the remaining points.



10e. Turn the model over and  
reverse fold the extra flap.



10f. Repeat the same sort of process  
on the next layer of folds, letting the  
flaps swing out from behind.



10g. Now, to complete the sink, fold  
the model up like a fan on the  
existing creases.



11. This is a completed spider  
base, lowered configuration.



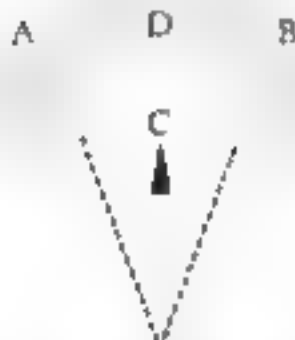
12. Preparing to petal fold – fold two layers upward, making a horizontal crease through only one layer, and unfold. This crease will be very important later.



13. Fold the sides in and unfold.



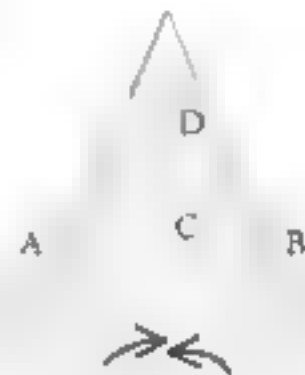
14. Fold the flap upward, forming two triangles which will pull the two sides in.



15. Starting the petal fold – grasp point D between thumb and forefinger and gently pull upward, then push point C inside out, forming a new lateral ridge along line AB (creased in the previous step) and creating a flat plane from line AB to point D. The side flaps will pull in naturally. The model will not be flat!



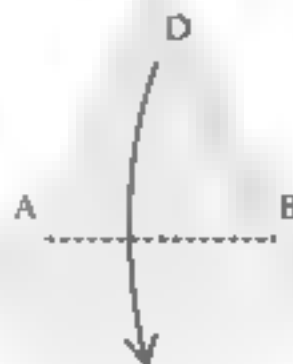
16. Continue the petal fold by molding two straight lines on the back of flap ADB, one from point A to point D and another from point B to D. There are no creases to guide you, it must be done by eye. As the fold is executed, you will have to form a pocket between the two ridges of paper, the one you are forming, and the one you precreased in step 14.



17. Complete the petal fold by continuing to flatten out the flap, readjusting the crease (forming the upper ridge so that it lines up with the lower ridge, bringing D all the way up into place) and flattening out the model completely.



18. This is an X-Ray view of the inside of the flap.



19. The petal fold sequence is complete. Fold the flap down.



20. Repeat steps 12-19 on the remaining four flaps.



21. Execute a twenty-sided sink. The inside needs to be perfect, but the outside should be



22. Gently pull the top flap downward until it meets the others. The model will not be flat, the sink at the top will pull open, and the flap will want to slip back to its previous position.



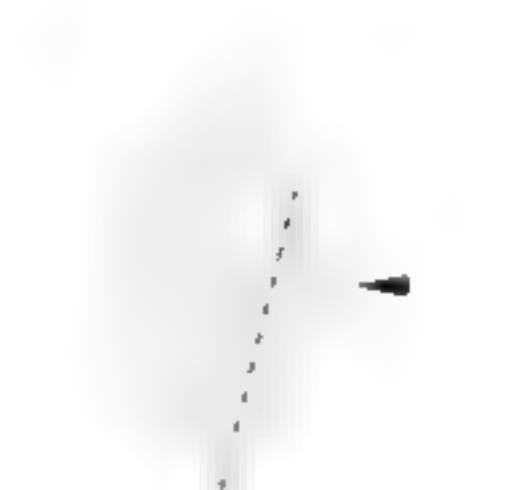
23. Execute "Nolan's Therapeutic Squash Fold", mush down all the stuff that's sticking up at the top.



24. Repeat steps 22-23 on the other four flaps



25. Fold and unfold the flap inward. Notice that there are three ridges of paper: the two on top should be aligned exactly, and all three should come to a point in exactly the same place.



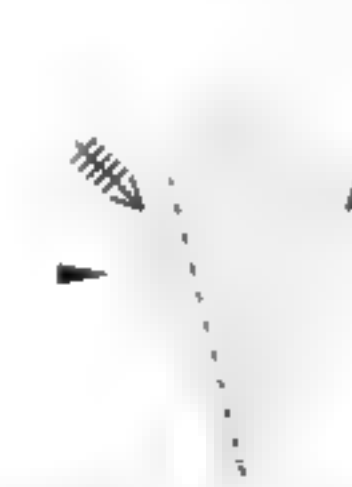
26. Pleat sink all three ridges simultaneously being careful that each ridge remains independent of the others. These sinks must be as perfect as possible. Now is the time to correct any messiness that occurred during the previous steps.



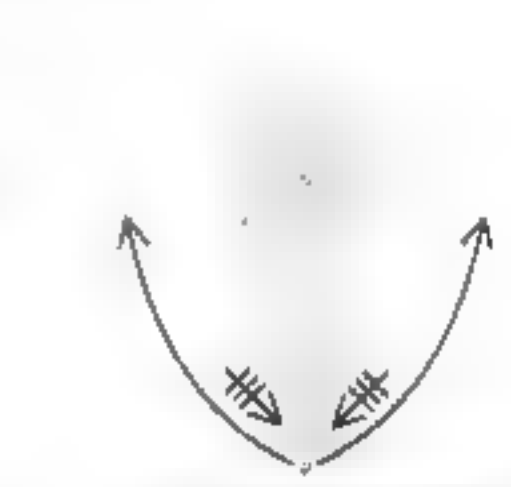
27. This is a side view of the three ridges, prior to the sink.



28. This is an intermediary view of the sink.



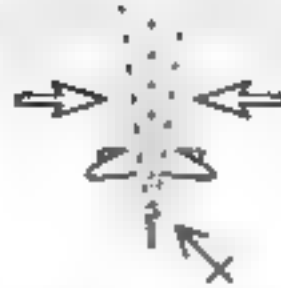
29. This is a view of the completed sink. There will be four ridges on the top flap and two on the lower. Repeat the sink on the other nine flaps.



30. Reverse fold eight legs, tiding from as far up inside the model as possible. Adjust the legs so that the topmost layer is most forward, and the lowestmost layer is most backward.



31. Gently insert a finger inside the model and open out the thorax, completely undoing the two sided link executed previously, but not any of the folding done to create the original five sided base. Take your time! It is very easy to destroy the model during this process!



32. To create the pedipalps, pinch the top and bottom flaps where indicated, taking the sides together and under to make them half size.



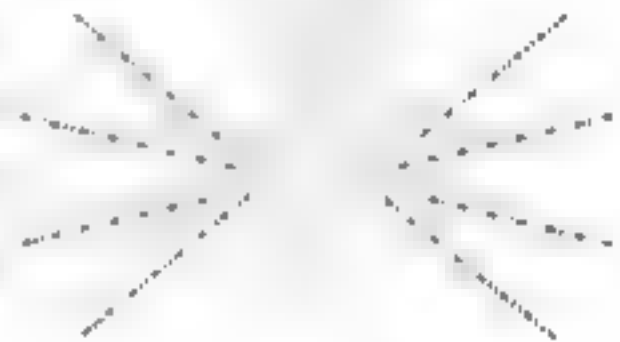
33. Push the top pedipalp to the right, the lower pedipalp to the left.



34. Thin the pedipalps by folding them in half.



35. Tuck the pedipalps inside the body, losing approximately one fourth their length.



36. Thin the legs by pinching them in half.



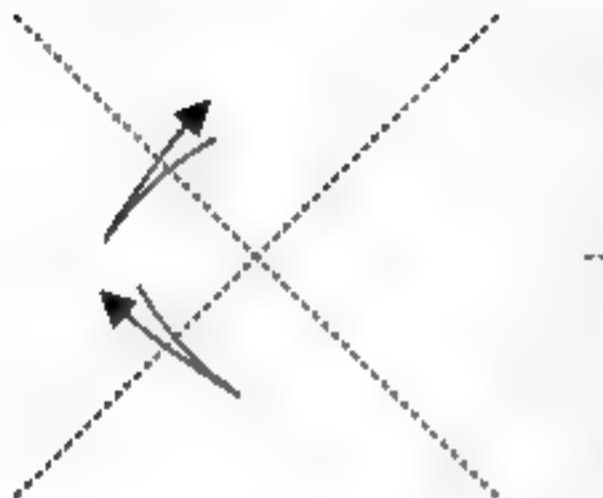
37. To complete the model, curl the legs so that they lift the body off the table. The pedipalps should lie just above the table.



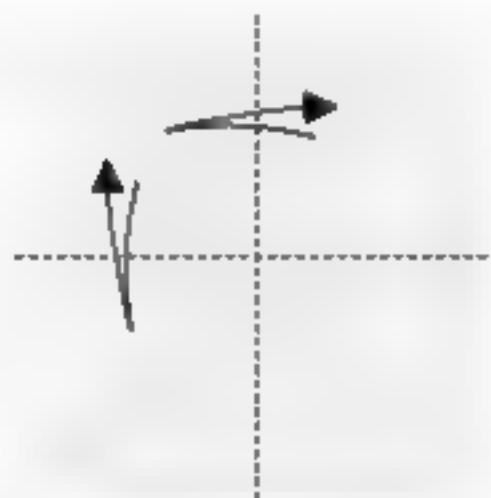
38. Top and side views of the completed model.



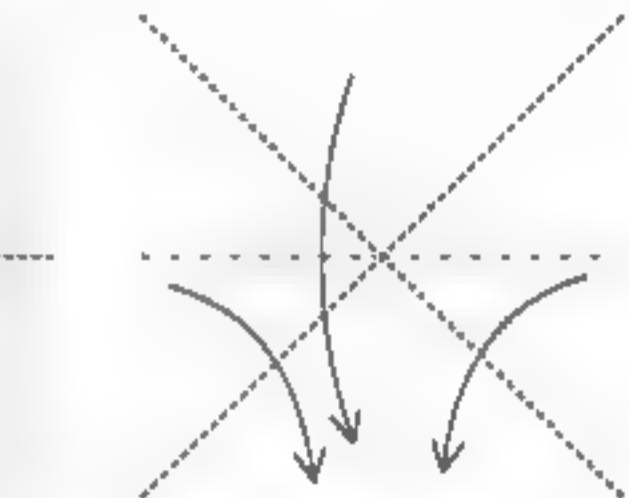
**Art Deco Lily** - It was with this model that I first discovered how to create, or at least one way I create. The base of the model containing the squash folds, was created by a friend who has never folded after I described the spider-base to him. I took the base (step 23), and pulled the sides down, completing the model. This is a classic example of first creating an abstract form then sculpting something recognizable from it. "Art Deco" refers to a decorative style prevalent in the 1920's and 1930's, that was highly geometric in form and was widely used in graphic design.



1. Fold and unfold along both diagonals. Turn the paper over.



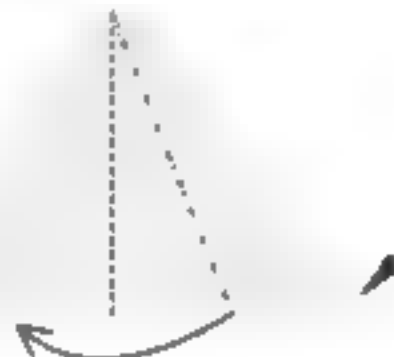
2. Fold and unfold the paper horizontally and vertically. Turn the paper over.



3. Fold a wide, smooth base on the existing creases.



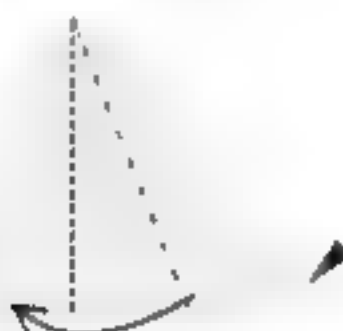
4. Fold and unfold the flap.



5. Squash fold the flap.



6. Turn the model over.



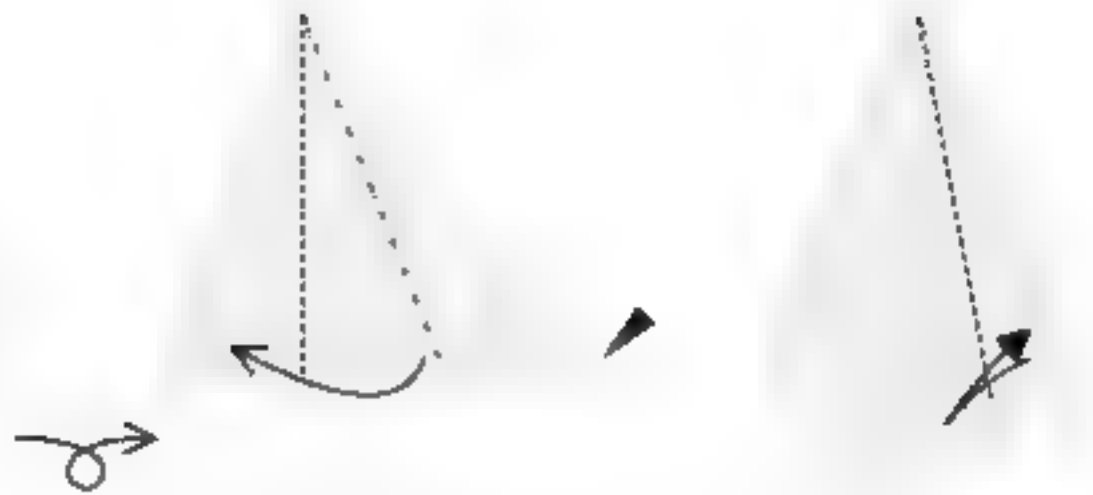
7. Repeat the squash fold on the other flap.



8. Fold one flap in front from right to left. Repeat behind.



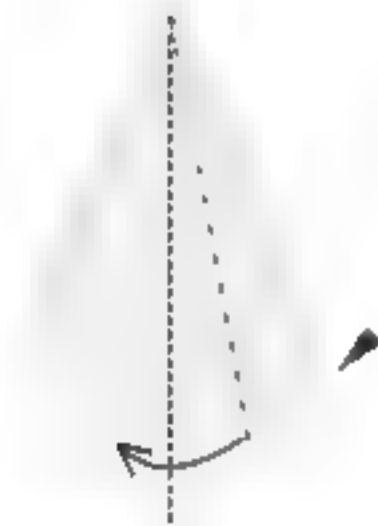
9. Repeat the squash fold on the next flap.



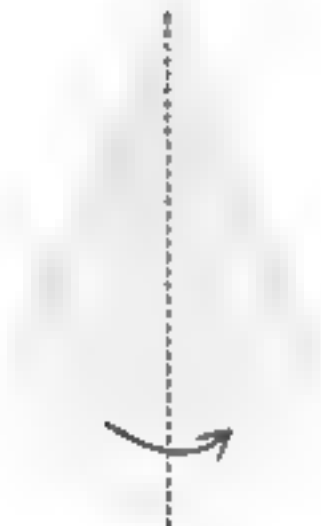
10. Turn the model over.

11. Repeat the squash fold.

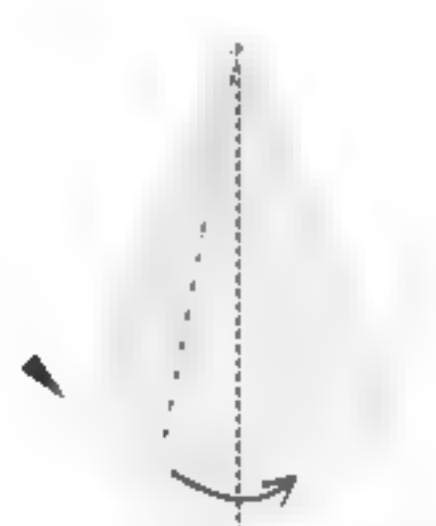
12. The first level of squashes is complete. Now we will squash fold each of the eight new flaps. Fold and unfold the first flap.



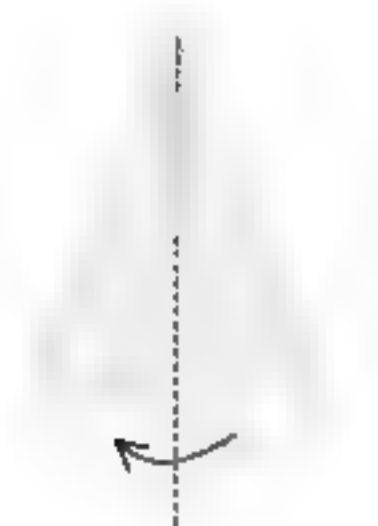
13. Squash fold the flap.



14. Fold the flap back.



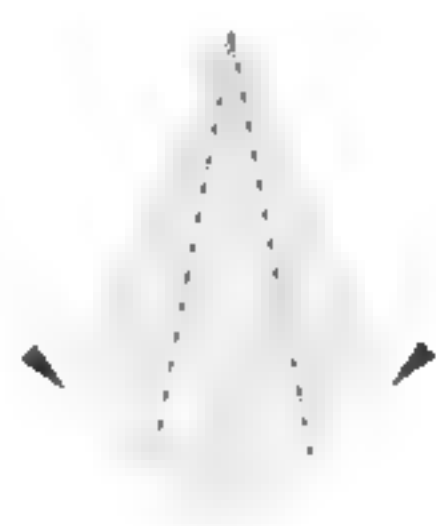
15. Squash fold the other side.



16. Fold the flap back.



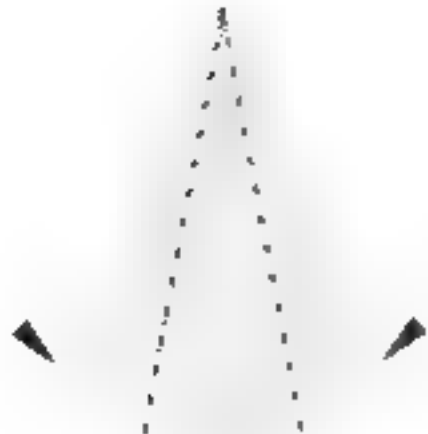
17. Turn the model over.



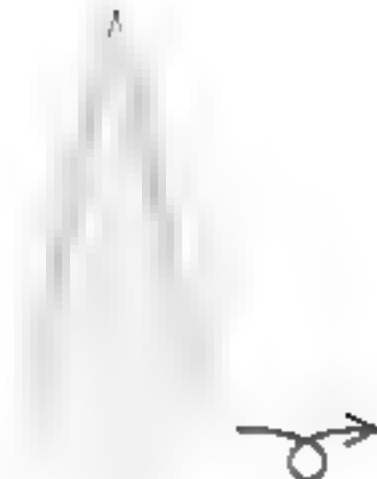
18. Repeat steps 13-16 on the next two flaps.



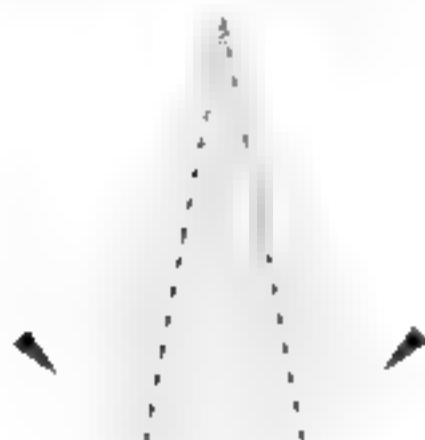
19. Fold two flaps in front from right to left, and two flaps behind from left to right.



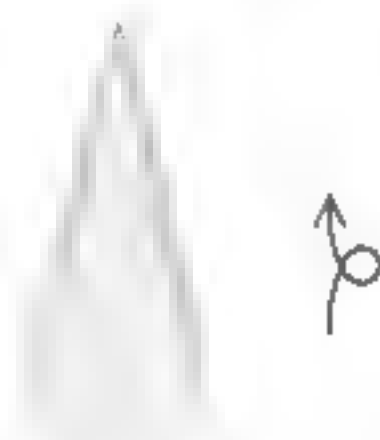
20. Repeat the squash folds on the new two flaps



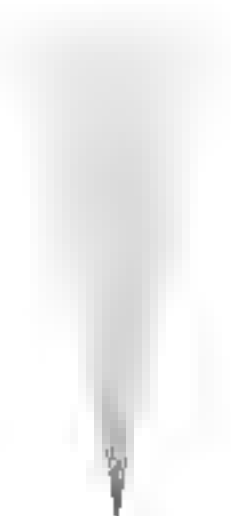
21. Turn the model over



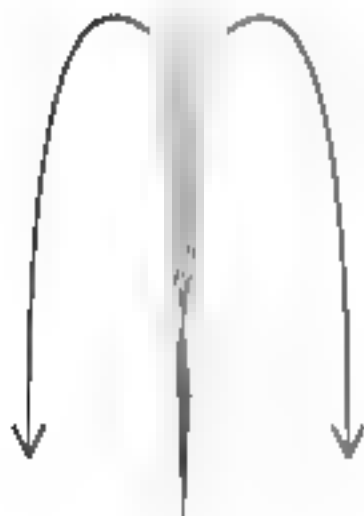
22. Repeat the squash folds on the next two flaps



23. Squash folds completed, flip the model over and turn it on its side



24. This is a side view of the model.



25. Pinch the model between your thumb and forefinger where indicated, and pull the two top points all the way down to the bottom. Do not crease!

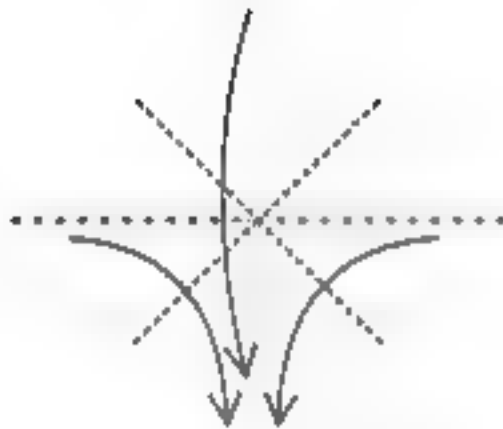


26. Now pinch the model at the bottom, holding the side flaps in place, and "fluff" the sides of the paper downward, like brushing a feather the wrong way. When completed, let go and the model will spring partly back into shape.



27. Completed model.

**Australian Leaf Bug** - This model was an experiment I did while developing my dragonfly. Since my dragonfly is created from a base very similar to an eight sided bird base I thought a standard bird base might be a good starting point for the legs, so the folds here were executed simply to test the theory. Once I had tried it on the standard bird base I incorporated the folds into my dragonfly. This model went by various names including "Aphid" "Stink Bug" and "Kite with Legs" but I chose to name it after an amalgam of plant invaders because that's what it looks like most. The model can be folded from any type of paper. A 10" piece of paper produces a model 6" long.



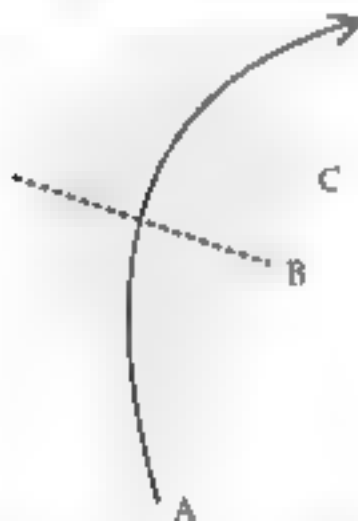
1 Start with a preliminary base



2 Petal hold the front and back flaps



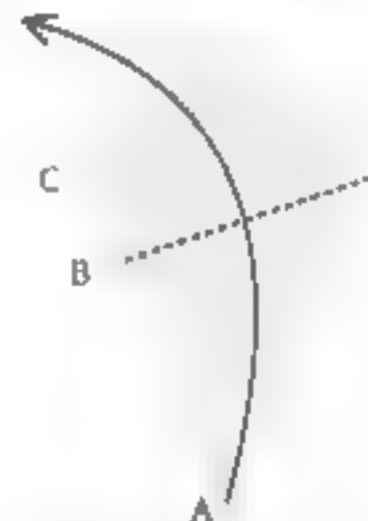
3 Fold the flaps back down.



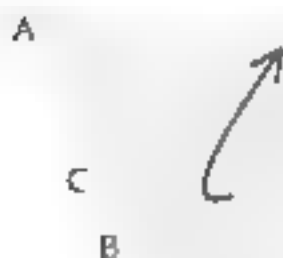
4 Fold the flap so that AB is parallel to BC



5 Fold the flap back down



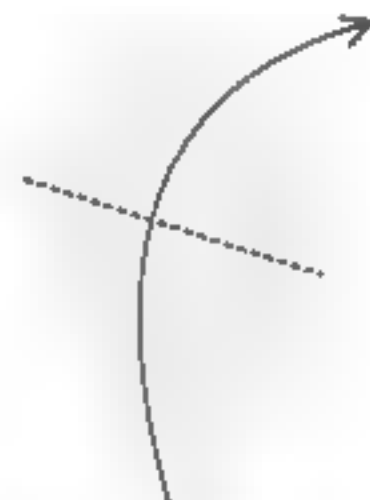
6 Fold the flap in the other direction



7 Pull up some loose paper



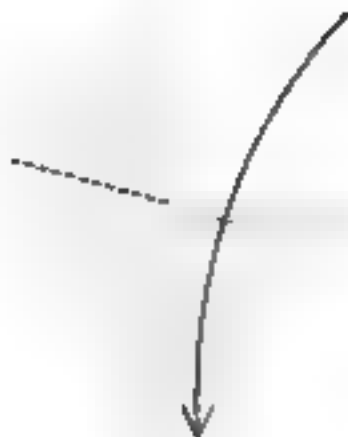
8 Fold the flap back down.



9 Fold the flap up on the existing crease



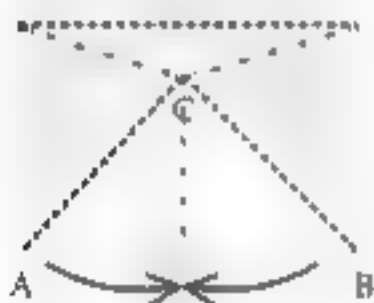
10. Pull up some loose paper



11. Fold the flap back down.



12. The two side edges should be parallel. Fold the flap up



! This is simpler than it looks. Pinch A and B together. C will pop upward and move forward. The white triangle will stick up. place it on the left.



14. Reverse and the white flap



15. Fold a single layer upward



16. Pull out some loose paper from behind.



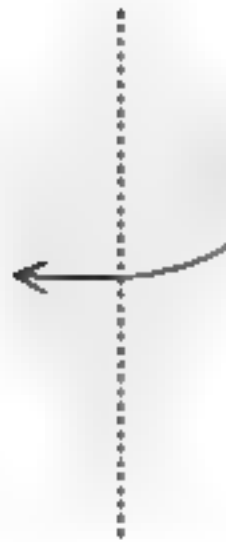
17. Fold the flap to the right.



18. Fold again



19 Fold the flap down.



20 Fold one large flap to the left.



21 Repeat steps 4-19



22 Fold one large flap to the right.



23 Repeat steps 4-19



24 Fold one large flap to the left.



25 Fold and unfold the flap.



26 Pull two layers to the right, spread squashing the triangle.



27 Sink the two areas tangentially.



28 Reverse fold the first set of legs



29 Turn each leg with two reverse folds, one to the outside of each leg



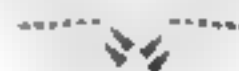
30 Reverse fold the next set of legs



31 Again, turn the legs with reverse folds



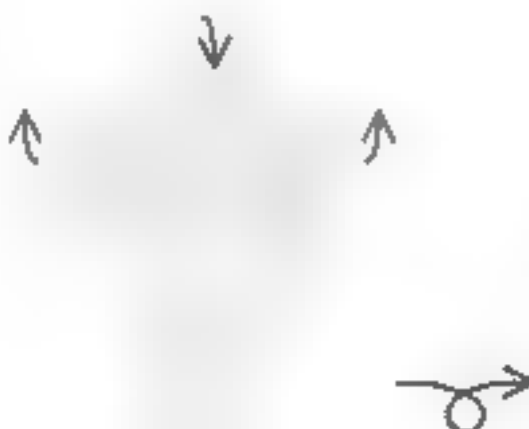
32 Reverse fold the final set of legs



33 Turn the final set of legs with four reverse folds up.



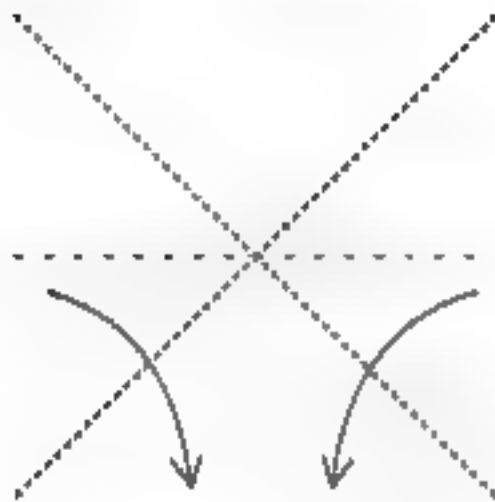
34 Followed by two more reverse folds back down on the back flaps.



35 Complete the model by curling the sides up and the tip down, and curling the legs down. Turn the model over

35 Completed model.

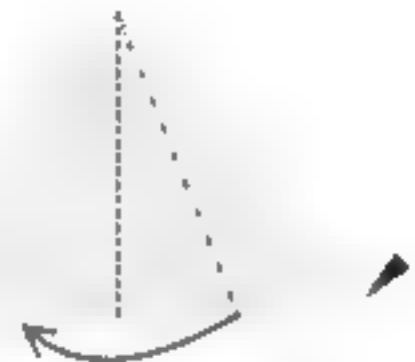
**Dragonfly** - This model was the first I attempted to create but definitely not the first that I completed. While working on it I first accidentally created the "Wolf Spider", the "Octopus", the "Tarantula" and the "Australian Leaf Bug" as well as the eight sided base used for "Cerberus". It is somewhat nelegant in its approach, but I feel it is important with respect to the other models in this book, so I have included it. It is very difficult to fold well, but with practice pleasing results are possible. Work with very thin, foil backed paper such as I use for A 10" piece of paper produces a model 4" in length.



1. Start by folding a waterbomb base, colored side out.



2. Fold and unfold the flap.



3. Squash the flap.



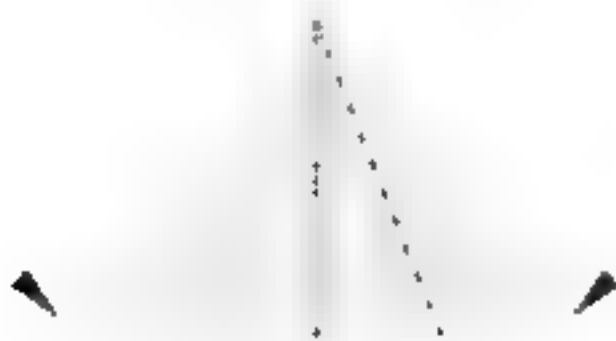
4. Turn the model over.



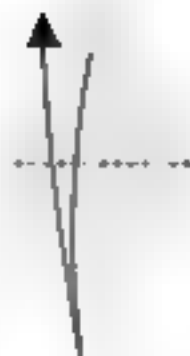
5. Repeat the squash fold.



6. Fold one flap from left to right (in front) and behind.



7. Repeat steps 2-6 on the remaining two flaps in front and behind.



8. Fold in half and unfold.



9. Fold the tip down to the edge of the paper and unfold.

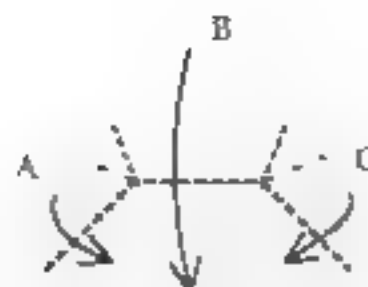


10. Execute a crimp sink on the two creases. The following steps detail the procedure.



Location of first  
sink inward

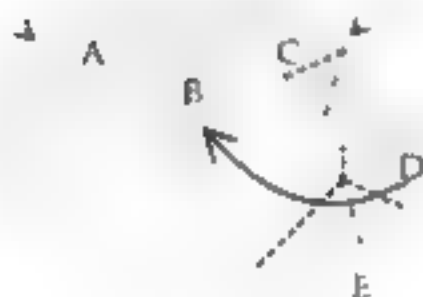
Location of second  
sink inward?



10a. Untold the model completely.  
Note the locations of sinks to be  
executed. Turn the paper over

10b. Bring the three points in to the center  
on the existing creases, folding the sides first,  
(A & C), and then the top (B). Don't worry  
about the lighter lines, just do the dark portions  
and the others will follow naturally

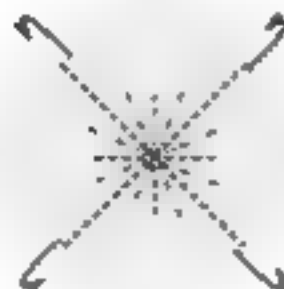
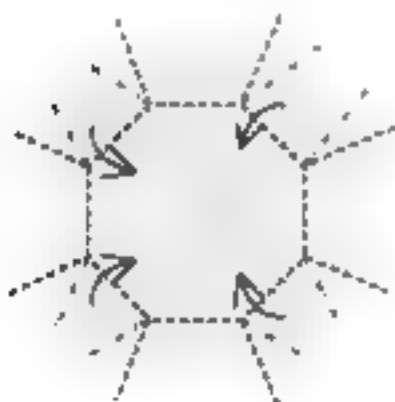
*Note: The creases on the sides will only come as far  
as the arrows indicate. The model is shown flat to  
clarify the folding procedure but is actually 3D.*



10c. Bring the next two points  
D & E to the center as in step 10b.

10d. Continue around the circle  
with the remaining points

10e. Turn the model over



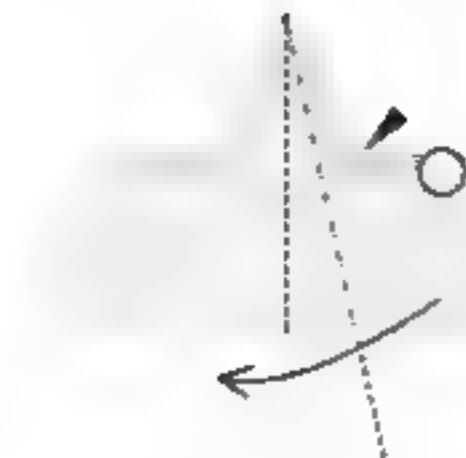
10f. Repeat the process on the next  
layer of folds, letting the flaps swing  
out from behind.

10g. Now to complete the sink, fold  
the model up like a fan on the  
existing creases.

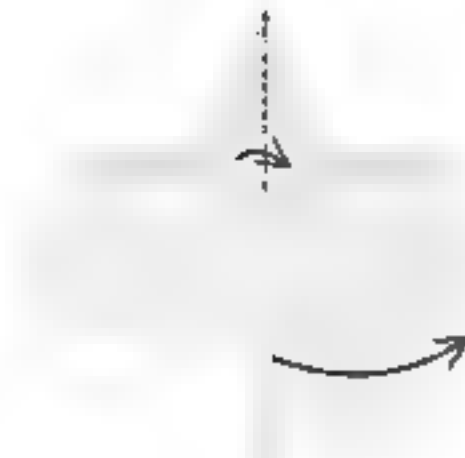
11 This is a completed spider  
base, standard configuration.



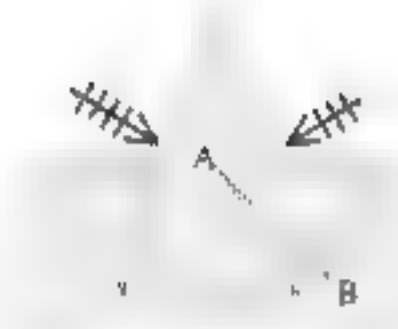
12 Fold and unfold all layers of the flap.



13 Pinch the flap where indicated and squash, flattening where the lines indicate but not flattening the flap that you are pinching. The model will not be flat.



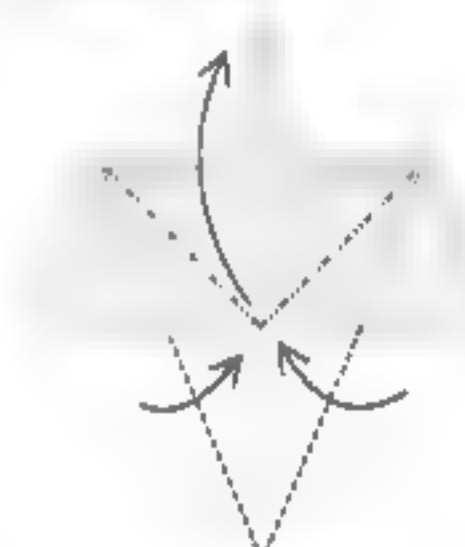
14 Now bring the flap back keeping the squashed area flat, and pulling the raised area back into it's previous position. An annoying third ridge of paper will appear between the two ridges (shown as AB in the following step) as you do this. Adjust the third ridge so that it matches the lines shown in the following illustration, sticking a finger inside the model and guiding it as you fold.



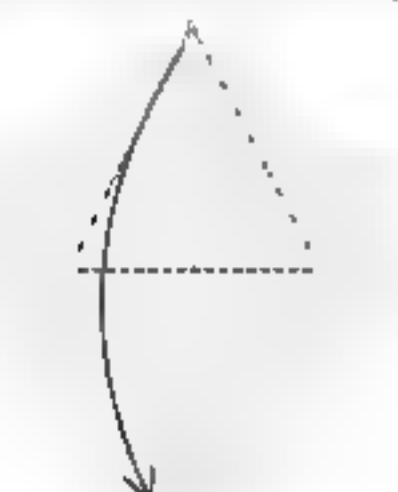
15 Completed squash. The dotted lines indicate an X-ray view of the hidden ridge and accompanying structures. Repeat the squash fold on the other seven flaps



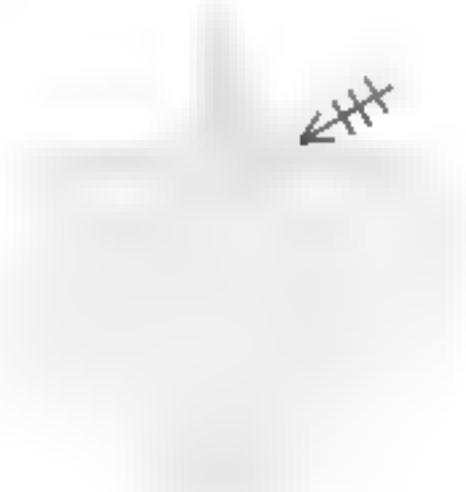
16 Prepare to double petal fold. Fold the flaps in and unfold.



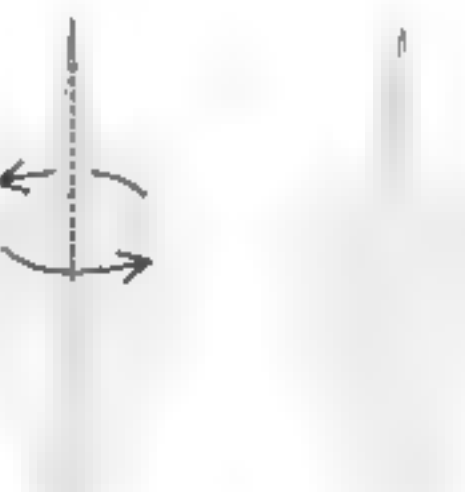
17 Petal fold upward.



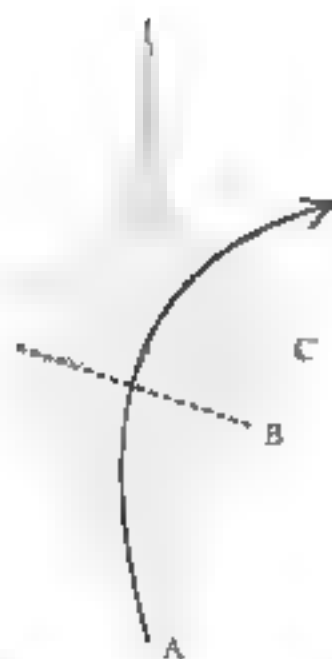
18 Petal fold in the opposite direction, being careful to keep all layers in place.



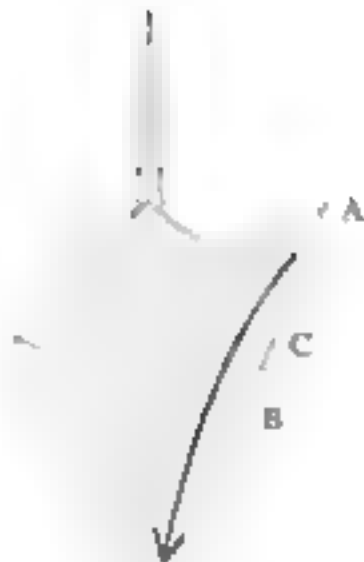
19 As you fold, the two side flaps will pull in and make the top flaps pop upward; mold it down so that it is as thin as possible. Repeat steps 16-19 on the other three flaps



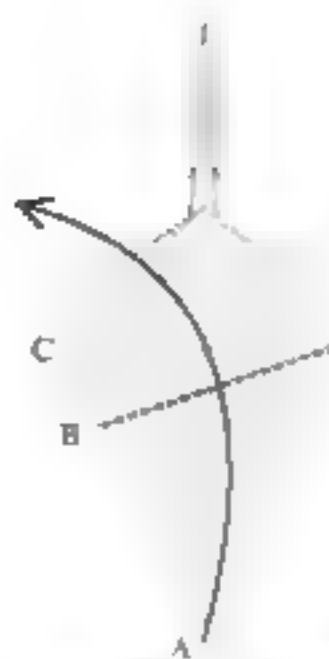
20 Completed eight-sided bird base with spike. Roll the indicated area between your thumb and forefinger to assure that the spike is as tight as possible. Fold one flap to the right in front and one flap to the left behind. There should be a smooth surface on the front and back of the model.



1 Fold the flap so that AB is parallel to BC.



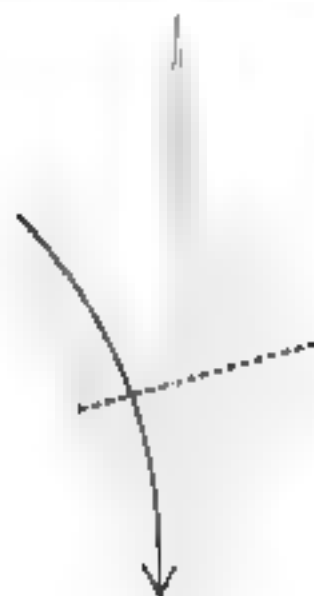
2 Fold the flap back down.



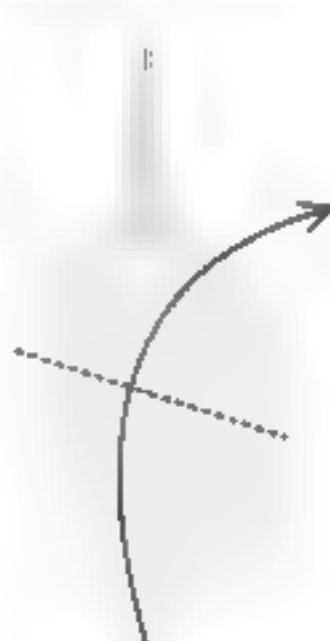
3 Fold the flap in the other direction.



4 Pull up some loose paper.



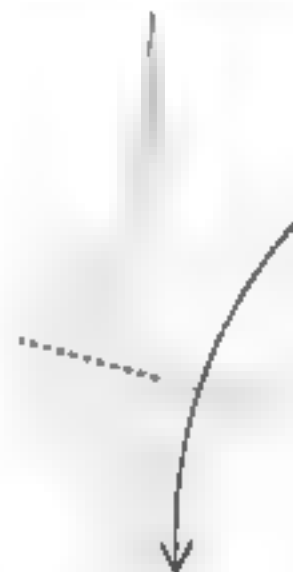
5 Fold the flap back down.



6 Fold the flap up on the existing crease.



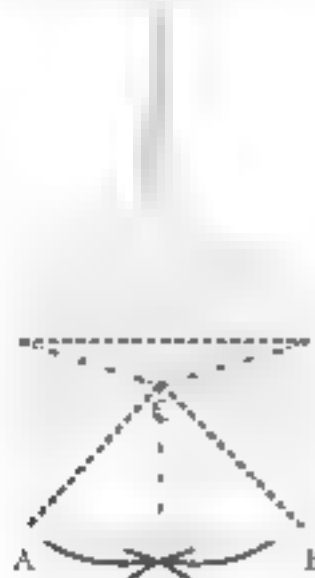
7 Pull up some loose paper.



8 Fold the flap back down.



9 The two side edges should be parallel. Fold the flap up.



10 This is simpler than it looks. Pinch A and B together. C will pop upward and move forward. The white triangle will pop upward, place it to the left.



11 Reverse fold the white flap.



12 Fold a single layer upward.



33. Put out some loose paper from behind.



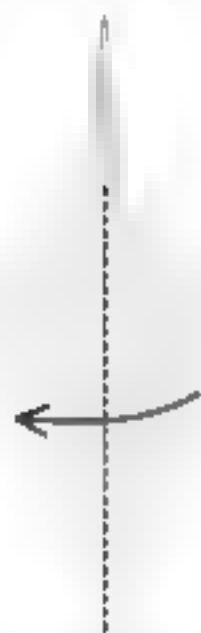
34. Fold the flap to the right



35. Fold again



36. Fold the flap down



37. Fold one large flap to the left



38. Repeat steps 21-36.



39. Fold two large flaps to the right



40. Repeat steps 21-36.



41. Fold one large flap to the left



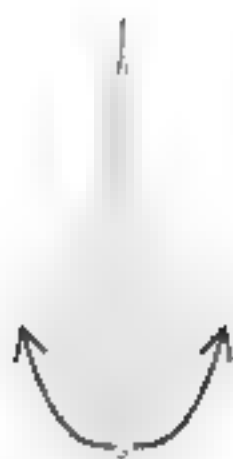
42. Fold and unfold



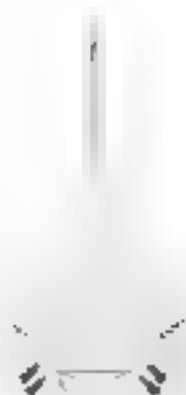
43. Pull two layers to the right, spread-squashing the triangle.



44. Sink the two areas triangularly.



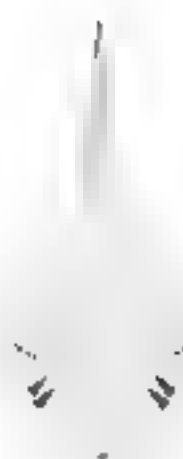
45 Reverse fold the first set of legs.



46 Thin each leg with two reverse folds, one to the outside of each leg.



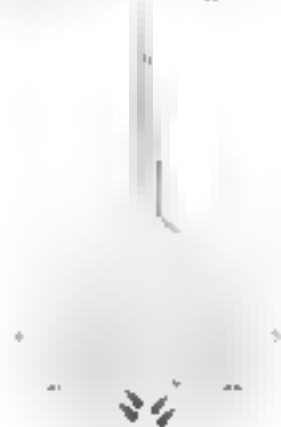
47 Reverse fold the next set of legs.



48 Again, thin the legs with reverse folds.



49 Reverse fold the final set of legs.



50 Thin the final set of legs with four reverse folds up...



51 ...followed by two more reverse folds back down on the back flaps.



52 Sink the back flaps triangularly

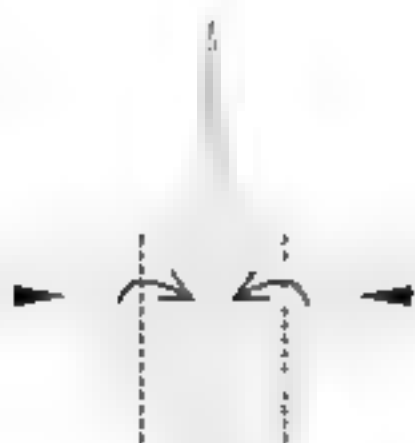


53 Turn the model over

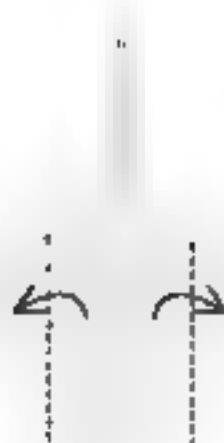
54 Reverse fold the upper wings maximizing their length. Notice that they are higher up inside the model than one might expect.



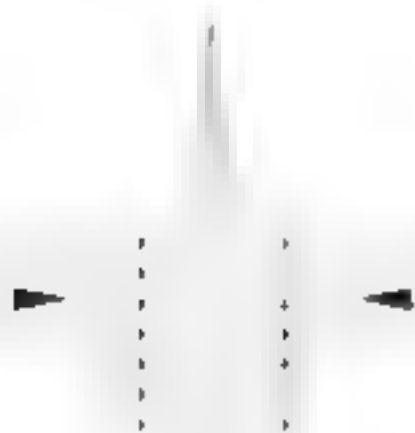
55 Reverse fold the next set of wings again maximizing their length. They are placed just slightly below the first set, and angled just below parallel.



56. Fold the two flaps inward, spread squashing the side areas as you fold.



57. Fold the flaps back.



58. Sink the side areas.



59. Turn the model over.



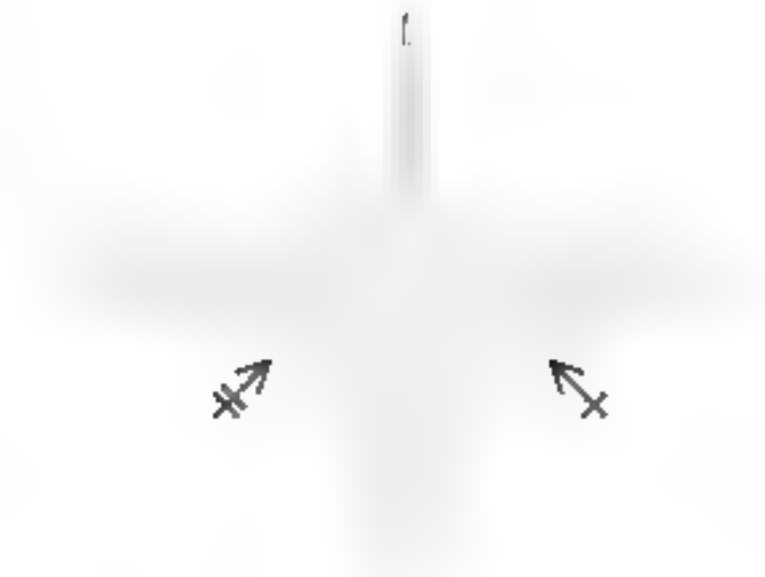
60. Turn the model by sinking the four indicated flaps, two on the bottom and two between the wings.



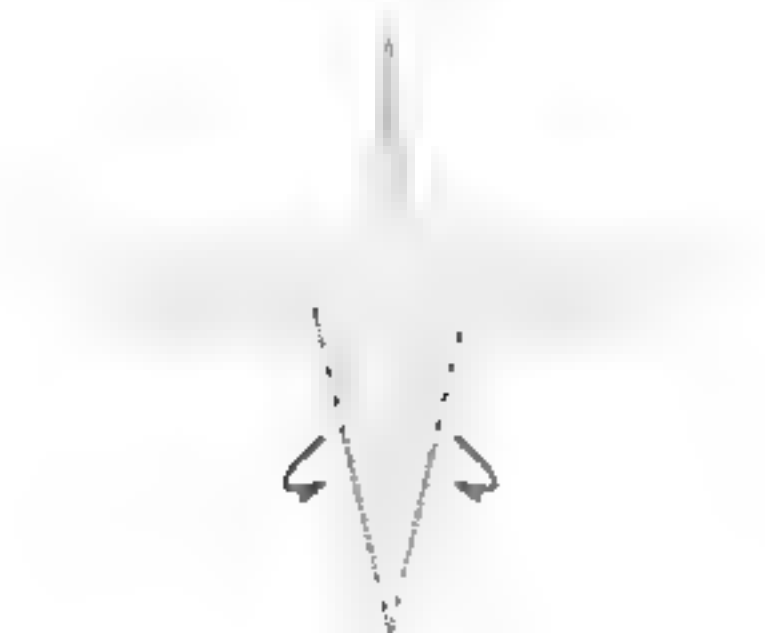
61. Turn the model over.



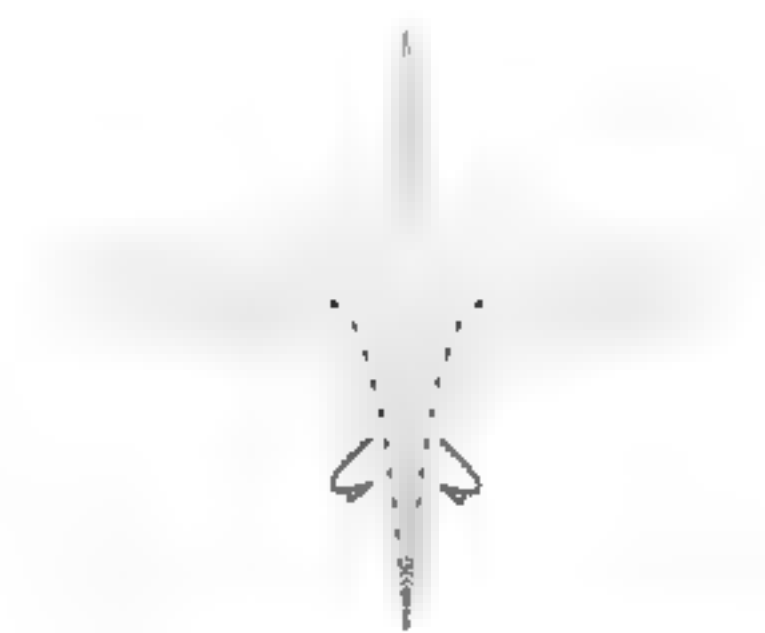
62. Shape the wing by folding the two flaps under and tucking the end inside



63. Repeat step 62 on the other three wings



64. Thin the tail



65. Thin the tail again and mold the model into final shape by compressing and rounding the body area and thinning and rounding out the tail

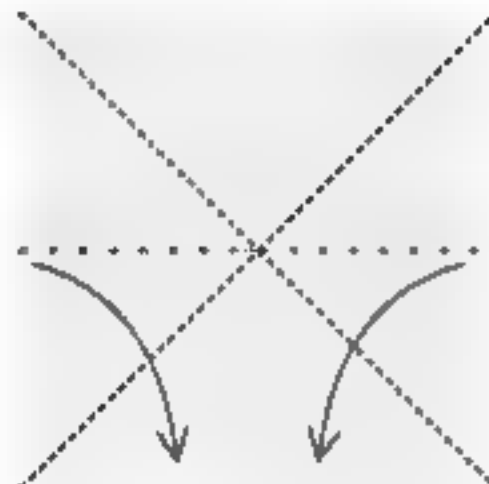


66. Form the head by opening up the spike at the top while pinching at the base. Curl the legs slightly and the model is complete.



67. Completed model.

**Hydra** - This was the first of the models that I created to show examples of what might be folded from an eight sided bird base. It is based primarily on technologies borrowed from other models. The basic structure is the same as the traditional crane, the head is very similar to that of John Montroll's "Struthiomimus" and the tail is taken from his "Rhamphorynchus" both of which can be found in his book "Prehistoric Origami." By combining the 5 and 8 sided bases in the "Experimentations" section, I have also created hydras with 7 and 13 heads. The model can be folded from any type of paper but foil backed paper works best. A 10" sheet of paper produces a model 5" in length.



1. Start by creating a waddumb base, white side out



2. Fold and unfold the flap



3. Fold the flap upward bringing point A to the center line



4. Fold the flap back down



5. Crimp on the creases.



6. Repeat the crimp on the other three flaps.



7. Fold one flap to the left



8. Fold and unfold.

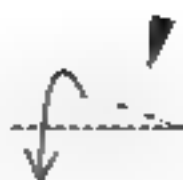


9. Sink the six sided area.





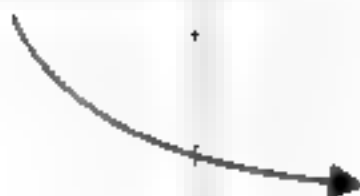
10. Fold and unfold.



11. Fold two flaps down causing the right side to spread sink.



12. Fold the flaps back up.



13. Fold the flap back.



14. Fold one flap upward, repeat behind.



15. Fold one flap to the right, repeat behind.



16. Fold one flap to the right, repeat behind.



17. Fold one flap upward, repeat behind.



18. Rotate 180 degrees.



19 Reverse fold the four flaps being extremely careful to keep the inside layers flat as if there were one continuous surface inside.



20 Completed eight flapped preliminary base. To create an eight flapped bird base petal fold each of the flaps as with a regular bird base.



21 Completed eight flapped bird base. Fold one flap in front and one flap behind to the right. There should be two points on the left and six points on the right and the sides should be one smooth surface, and not have a split down the middle.



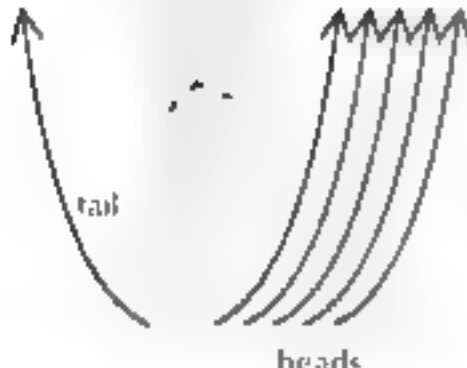
22 Fold the flap up, repeat behind.



23 Mountain fold the flap, repeat behind.



24 Execute sinks on all six flaps. The outside sinks look triangular but are not quite, the inner sinks are delta shaped.



25 Reverse fold the heads and tail. Note the angle on heads is higher than on the tail.



26 Outside reverse fold the heads downward. The distance should be approximately one sixth the length of the neck. The heads tend to grow as you fold them, so err on the side of the smaller.



27 This is a detailed view of one head. Pull down some loose paper from both sides of head.



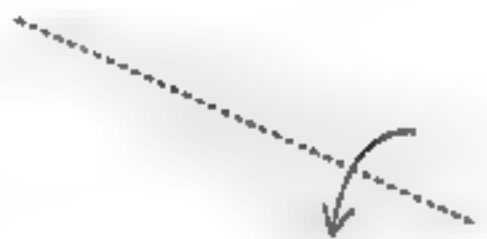
28. Reverse fold downward to shorten the snout then back down to form a beard.



29. Completed head. Repeat on the others.



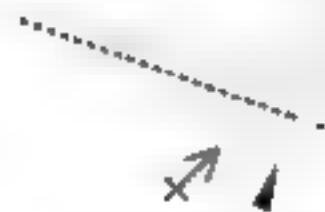
30. Open up the tail.



31. Fold the tip of the tail inward, opening up the side flaps as you go.

32. Fold the bottom of the tail back up.

33. Fold the tail back down.



34. Reverse fold to thin the tail. Repeat behind.



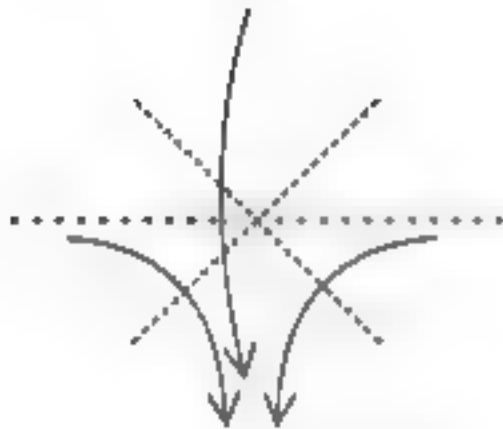
35. Pull the wings back and curl the tail downward.



36. This extremely nasty, 16 sided sink can be left out if it is too intimidating. Arrange the heads so that they are all visible.

38. Completed model.

**Taarakian Dragon Glider** - This model was created accidentally. It was originally a piece of scrap paper which I was using to test various folding techniques: a bird base, a double swan's fold, and a sink. One day I noticed that it looked vaguely like a dragon, so I added the head and feet to make it look more authentic. It was a complete surprise that it flies. The model can be folded from any type of paper, though for barked papers other than Japanese tori tend to be too heavy to fly well. A 10" piece of paper produces a model with a 7" wingspan.



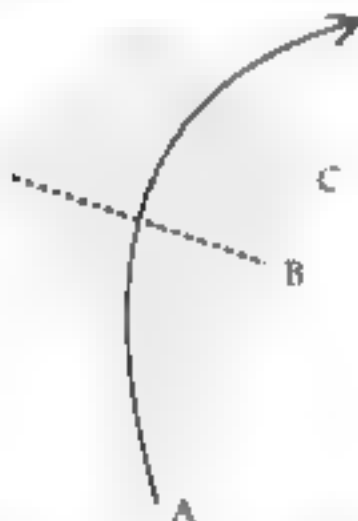
1 Start with a preliminary base



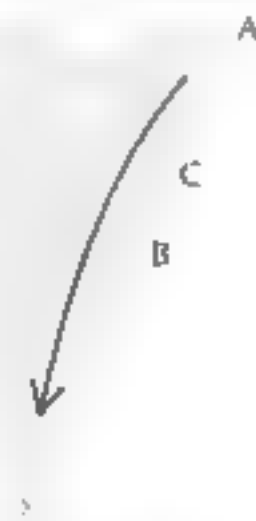
2 Petal fold the front and back flaps



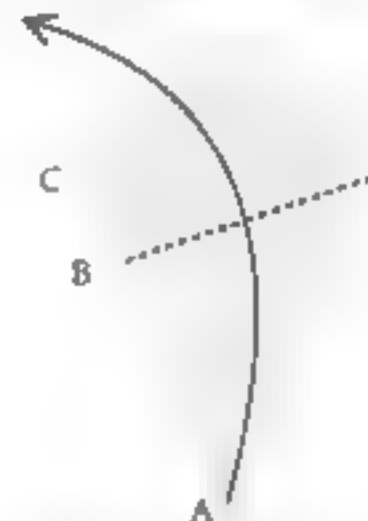
3 Fold the flaps back down



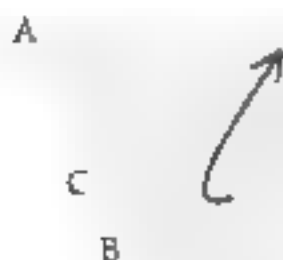
4 Fold the flap so that A is parallel to BC



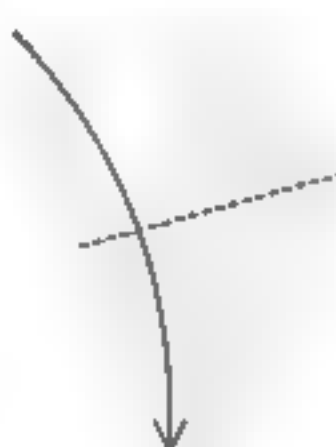
5 Fold the flap back down



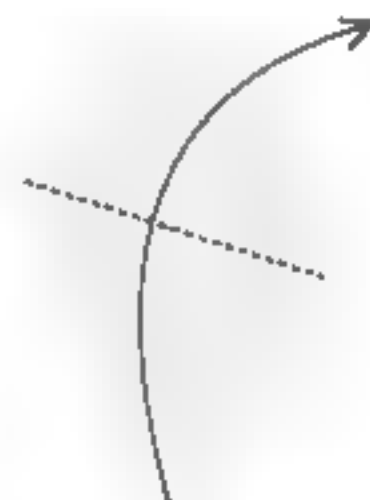
6 Fold the flap in the other direction



7 Put up some loose paper



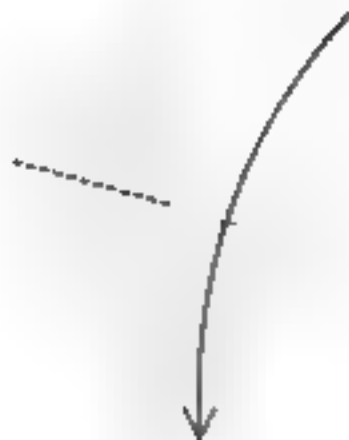
8 Fold the flap back down



9 Fold the flap up on the existing crease



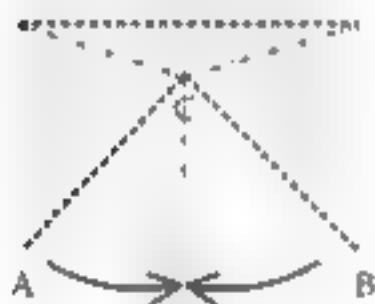
10. Pull up some loose paper.



11. Fold the flap back down,



12. The two side edges should be parallel. Fold the flap up



13. This is simpler than it looks. Pinch A and B together. C will pop upward and move forward. The white triangle will stick up. Place it on the left



14. Reverse fold the white flap



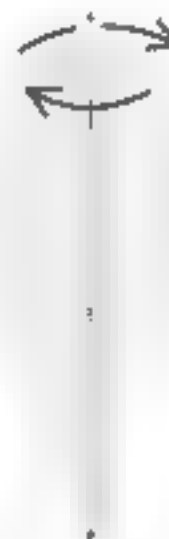
15. Fold a single layer upward



16. Pull out some loose paper from behind.



17. Fold the flap back down



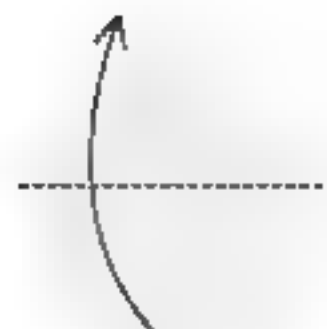
18. Fold one flap in front to the left; one flap in rear to the right



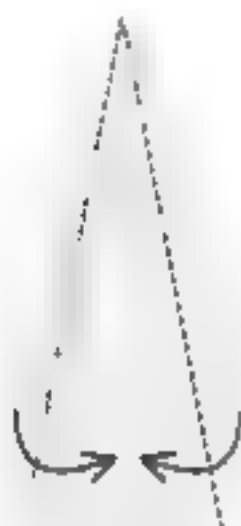
19. Sink the not quite triangular area. Repeat behind.



20. Fold one flap to the left.



21. Fold the flap up.



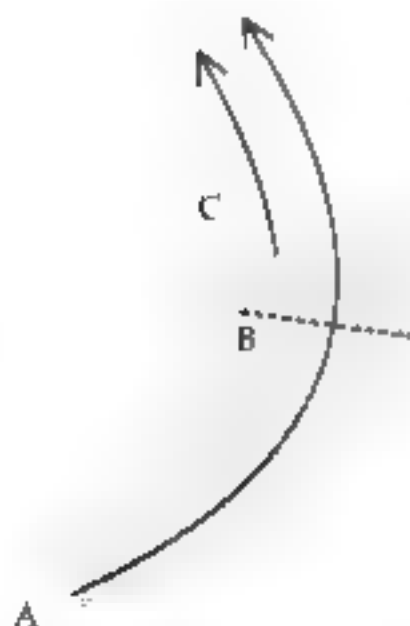
22. Fold the sides in.



23. Fold the flap back to the right.



24. Rotate the model 45 degrees.

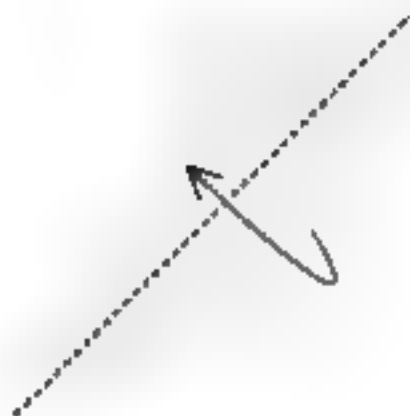


25. Fold the wings upward so that AB is parallel to BC. These lines are very important if the model is to fly well.

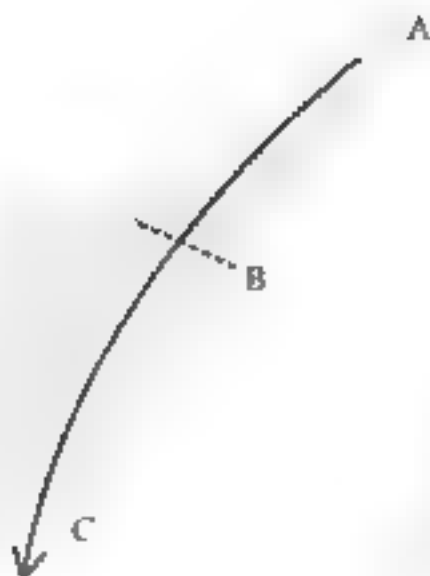


26. Assure that the wings are exactly the same size and fold them back down.

*Note: The model is aerodynamically stable at this point. If the wings are folded downwards, perpendicular to the body, the model can be launched with a very gentle glide. The rest of the folds are mostly decorative, except for the wing flaps which are used to adjust for the decrease in stability caused by creating the feet.*



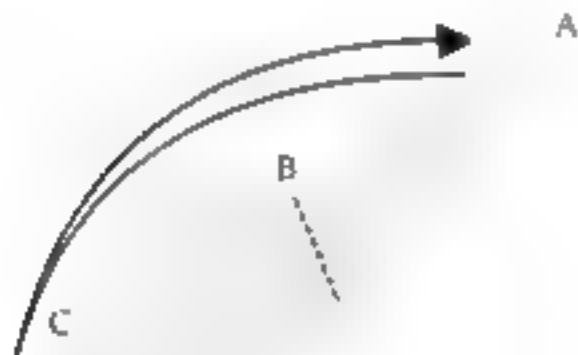
27. Fold the flap up.



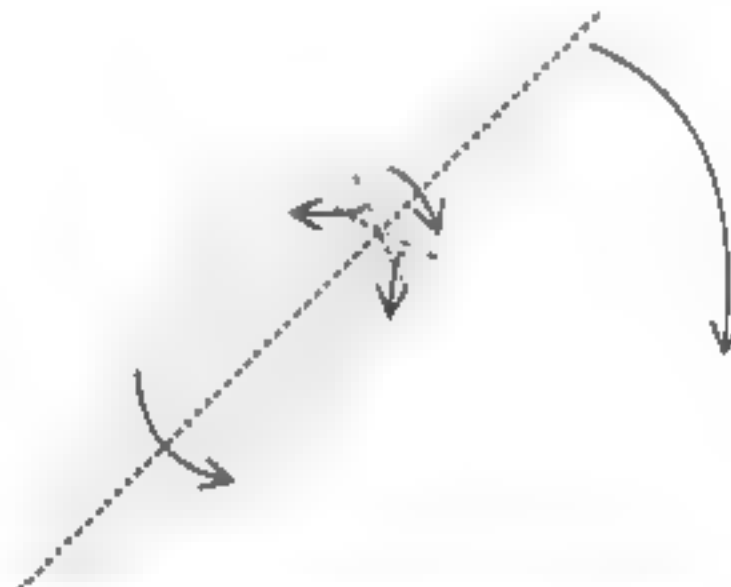
28. Fold the neck down from B so that AB is parallel to BC. Part of the fold will be under the middle triangle of paper.



29. Fold the flap back up.



30. Repeat on the other side, fold and unfold.



31. Fold the flap back up, creasing in two places. When completed, the upper edge of the neck should be a single edge.



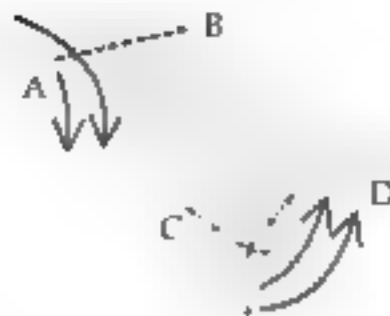
32. Sink the twelve sided area from just above the top of the neck to the edge of the two ply area in the rear. This is difficult but possible.



33. Mountain fold two layers, inside the model. One layer should cross the tail and lock it in place, the other will just lay to the side.



34. Fold the wings back up.



35. Fold two inside rabbit ears to create feet. Fold the edges of wings down to create vertical stabilizers. Note that AB should be parallel to CD.

46. Complete dragon. To fly, adjust the wings and vertical stabilizers so that they appear as shown in the rightmost illustration. Launch: hold the model by the feet, squaring them together as much as possible, and gently glide with a slight upwards motion. If the model does not fly well, try adjusting the wing or vertical stabilizer angle, or creating larger vertical stabilizers. Also, if the model is folded from foil, the vertical stabilizers can be added as curves by wrapping the edge of the paper around your index finger, creating a nice rounded edge at the wing. Curved wings are just as stable as the straight edged type.



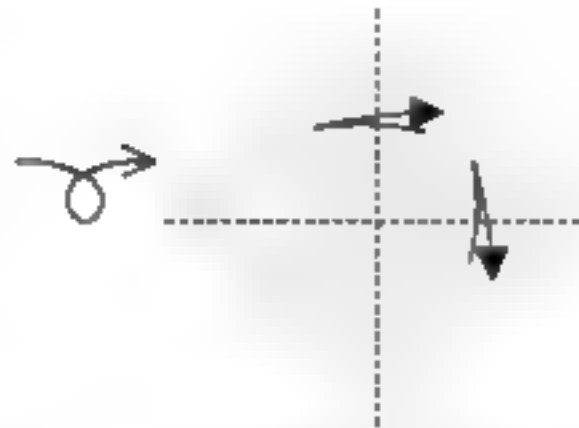
37. The model also likes to sit on flat surfaces. To make the model sit, adjust the feet so that they are angled lower and spread them apart slightly, pull the wings back so that they are out of the way, and sit the model on the corner of a table.



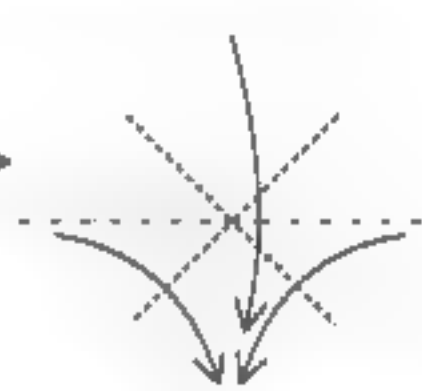
**A Simple Dragon for Natasha** - This model is exactly the same as my hydra, but with only one head. I created it for my friend Natasha who folds miniature origami jewelry. She prefers simple models because they can be folded quickly. I thought it would be nice to have a simple dragon and that's where I got the idea for the model. Unfortunately, it's not all that simple; it includes triangular sinks and other folds that make it an intermediate level model. It can be folded from any type of paper. A 10" piece of paper produces a model 6" in length. It also makes a wonderful miniature



1. Fold and unfold laterally. Turn the paper over.



2. Fold and unfold diagonally. Turn the paper over.



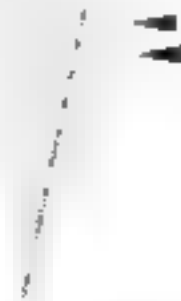
3. Bring all four corners together, forming a preliminary base on the existing creases.



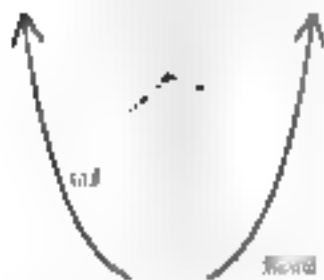
4. Partial fold the front and back flaps.



5. Mountain fold the two flaps inside.



6. Sink the two triangular areas.



7. Reverse fold the head and tail upward. Note that the head is at a higher angle than the tail.

tail



8. Outside reverse fold the head. The distance should be approximately one sixth the length of the neck. The head tends to grow as you fold it, so less than one sixth is better than greater than one sixth.



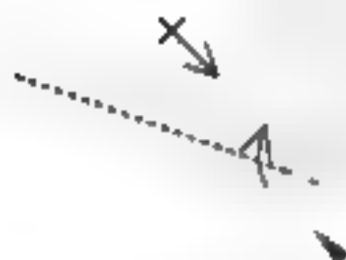
9. Pull down some loose paper from both sides of the head.



10. Reverse fold inside to shorten the snout, then back out, to form a beard.



11. Fold the tips of the tail downward, opening up the side flaps as you go.



12. Reverse fold to thin the tail. Repeat behind.

13. This is the completed head.



14. Fold the triangular area outward.



15. Open up the tail.

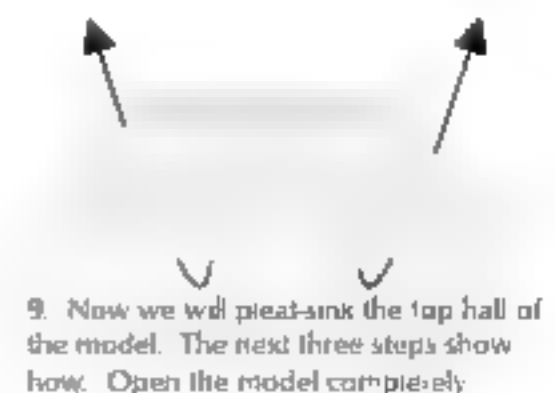
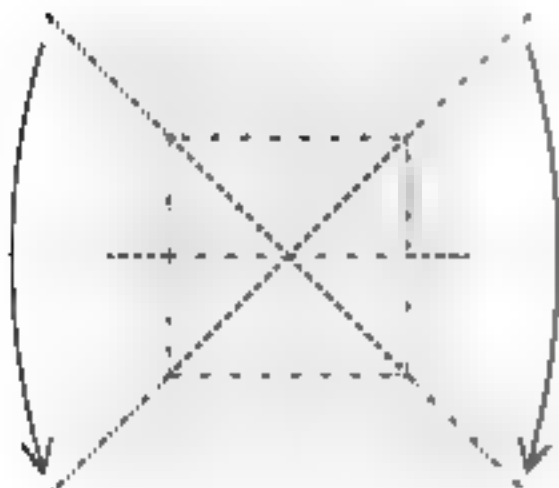
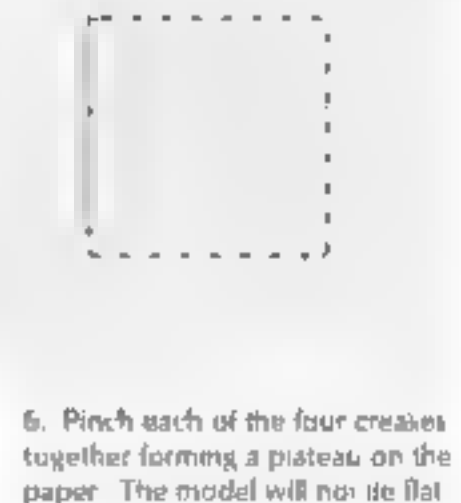
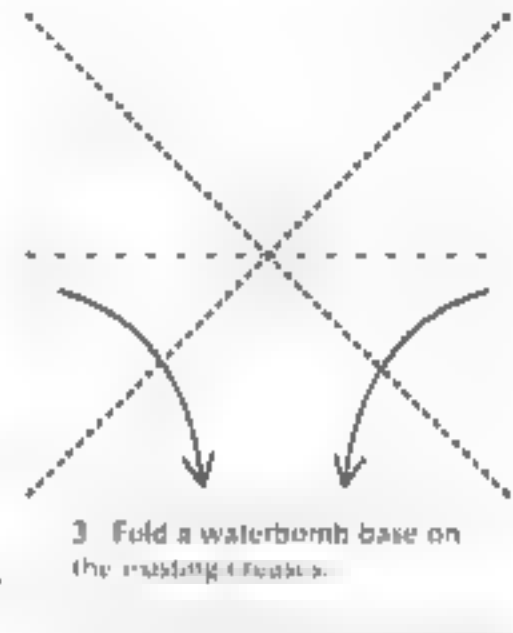
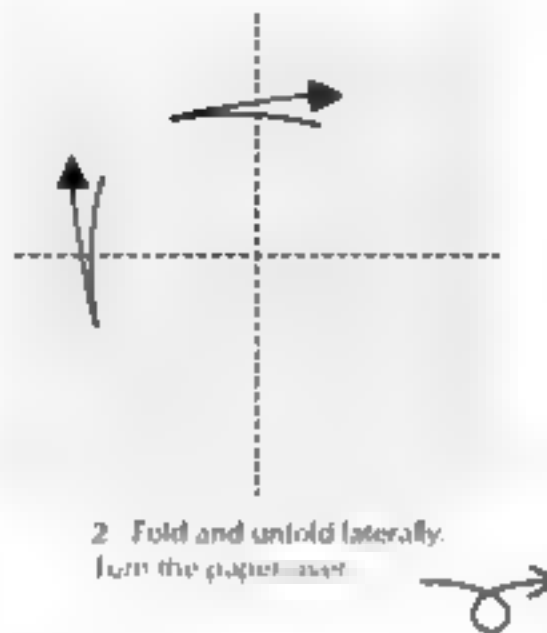
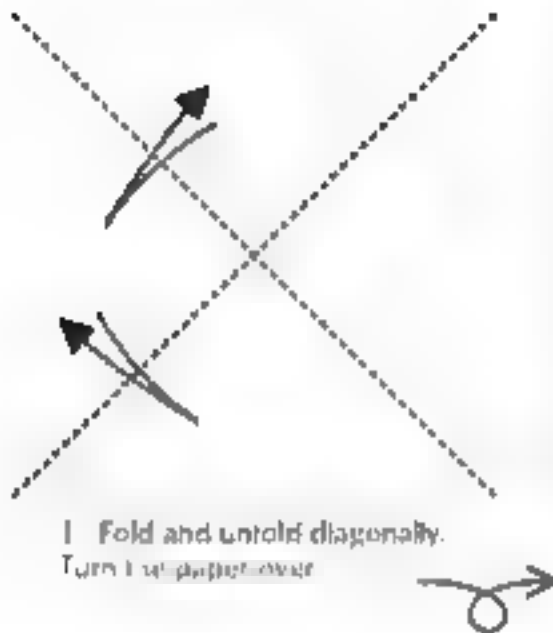
16. Close the tail back up.

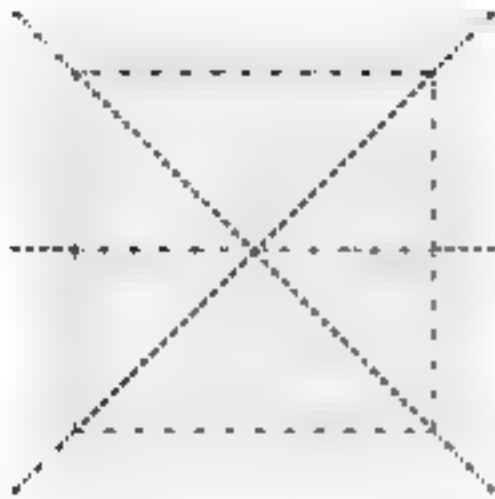


17. To complete the model, pull the wings back and curl the tail downward.



**Butterfly** - This model and its sister model "Andrea's Rose" were created as sinking exercises. Sinking is not as difficult as it seems, and after learning the proper technique with practice it becomes quite easy. This model concentrates on the "pleat sink" type in which a piece of paper is unfolded completely and refolded like a fan. The model can be folded from any type of paper though foil backed papers are more difficult to work with.





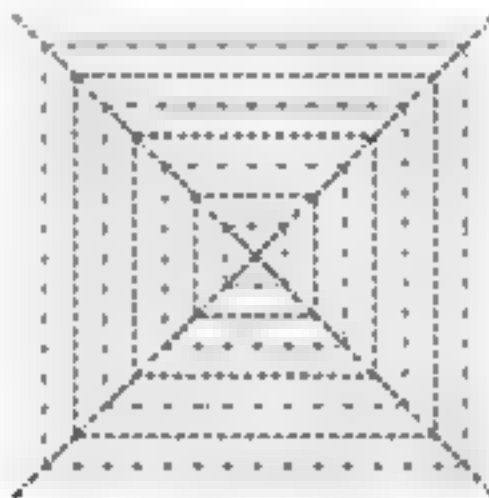
10. Pinch the numerous creases indicated by the thicker lines into shape just like in step 8. Then, incorporate the rest of the creases, folding the model back into a waterbomb base.



11. Next sink the white area upward using the same approach used in the previous steps: open the model partly, pinch the new creases into place, and fold the model back up.



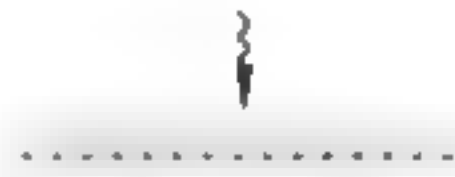
12. Sink the last area. This will complete the pleat sink.



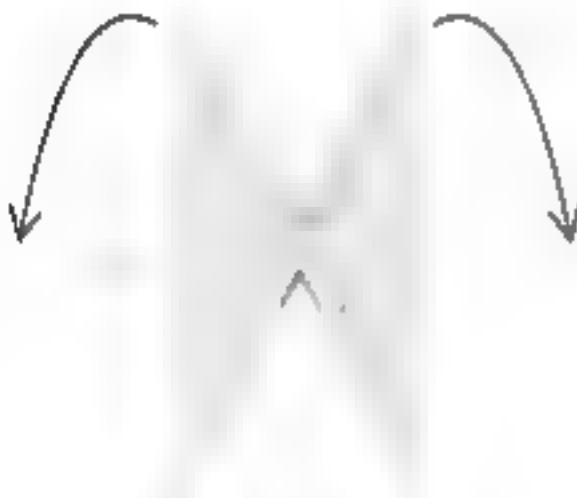
14. Fold the paper back up as in the previous steps but with twice as many folds. Start with the outside square and work inward, one level at a time.



13. Pleat sink the next level. As before, fold the model in half very accurately and then unfold the paper completely.



15. Pleat sink the final level.



16. This is a simplified view. To complete the model, pinch the paper closed, just under the horizontal center. The top flaps will flip down and to the sides automatically.

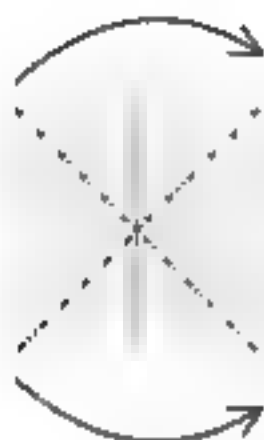


17. This is another simplified view. Allow model to open up.



18. Completed model.

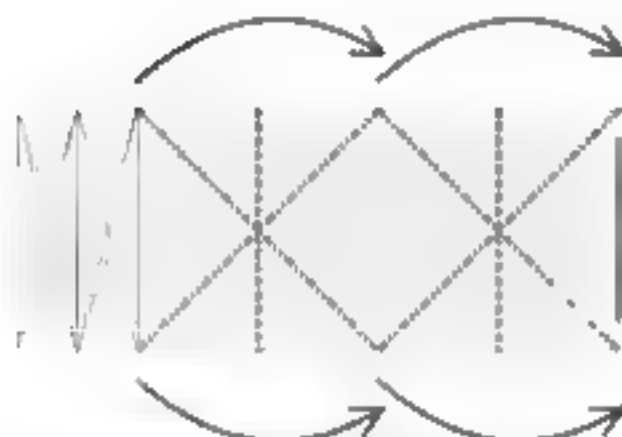
**Butterfly Chain** - I created this model after designing the "Butterfly". It struck me that in my butterfly since two of the edges of the paper were left completely intact, then one could probably string a chain of butterflies together connected by the wings. That night I sat down and folded it. The model is good practice for folders who want to increase their comfort level with sinking as well as improve their precision skills such as tudging creases to make things line up correctly. The model can be folded from any type of paper, though kami works best for beginners.



1. Start with a 1 by 4 piece of paper with each square marked with a crease. This example shows a 1 by 4 piece of paper. Fold a waterbomb base on the first square.



2. Fold a waterbomb base on the next square.



3. Continue folding waterbomb bases on the rest of the sections.



4. Now you have a chain of waterbomb bases.



5. This is a side view. Sink the top of each waterbomb base.



6. As with the butterfly, pleat-sink each portion.



7. Pleat-sink each portion again.

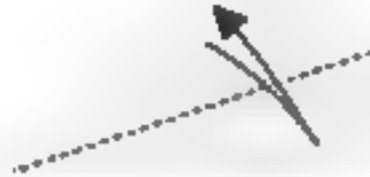


8. This is the completed model. It works like a little wind up toy. Try holding each end of the model with either hand and gently winding it up like a rubber band. Let go and it will spring back into shape.

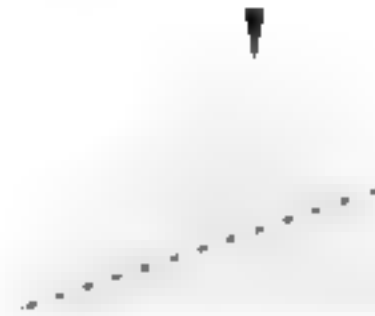
**Delta Glider** - After creating my butterfly I was intrigued with the concept of creating other interesting shapes or models based on the same approach. Folding a model from a triangle was an obvious direction in which to go. After folding the model it struck me that it looked like a delta winged airplane so I gave it a toss to see if it would fly. It did. So, as with the "Taarakian Dragon" my other glider in this book, I had no intention of creating something that was aerodynamically stable. It was an accident. The model should be folded from a large sheet of kami. Other types of paper do not perform as well.



1. Start with a square cut in half diagonally. Fold in half.



2. Fold downward very accurately, and unfold.



3. Reverse fold on the existing creases.



4. Fold and unfold.



5. Sink the triangular area.

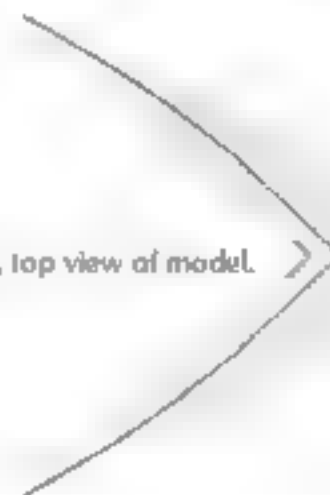


6. Continue with the next level, pleat-sinking as with the butterfly.



7. Pleat-sink one last time, for a total of four ridges, any more and the model will not fly.

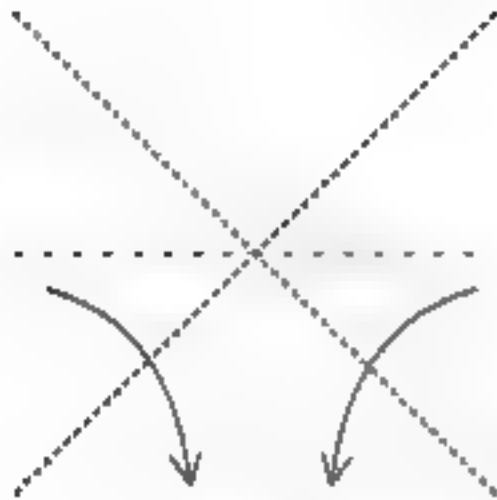
8. This is a simplified, top view of model.



9. Reverse fold the nose and place a medium sized paperclip over the end as a counterweight. The proper point of balance is 7/16 back from the nose.

10. To fly, pinch the model together (just behind the point of balance) tilt slightly upward and launch. Try different amounts of launching force. This model can really rave with the right amount of force. Eventually, the model will wear out and not fly as well.

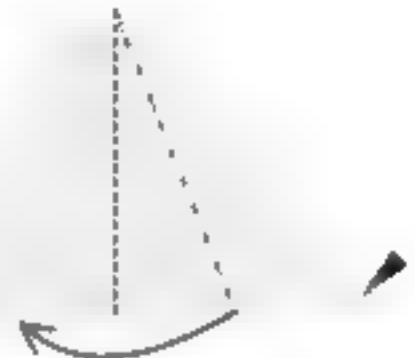
**Cerberus** - Cerberus is the three headed dog in Greek mythology who guards the gates of Hades. This model is the third piece, along with the "Hydra" and "Pegasus" which I designed to show what one might do with an eight sided bird base. It borrows heavily from Crawford's "Unicorn" right down to the stretched bird base, the color changes used on the head, and the structure of the tail. It should be folded from some sort of foil backed paper. A 10" piece of paper produces a model 4" in length.



1. Start by folding a waterhomb base, colored side out



2. Fold and unfold the flap.



3. Squash the flap.



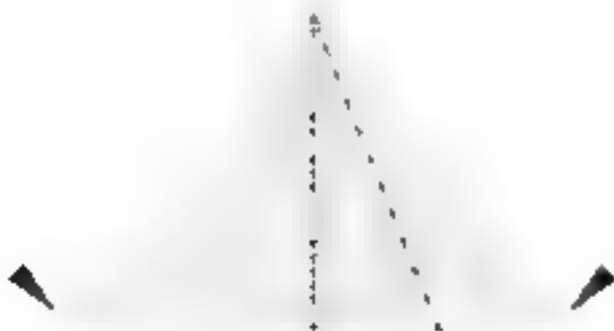
4. Turn the model over



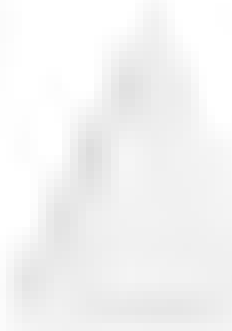
5. Repeat the squash fold



6. Fold one flap from left to right in front and behind



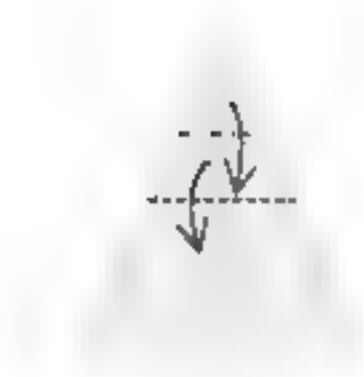
7. Repeat steps 2-6 on the remaining two flaps in front and behind.



8. Finish with the model open. To complete the base we will perform a crimp sack on the eight sided form.



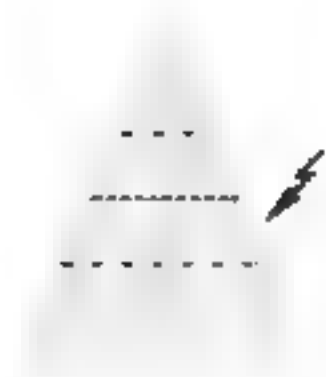
9. Fold the tip down and up



10 Fold the top half in thirds.



11 Unfold to step 10.

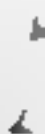


12. Execute a triple crimp sink in the three creases. A detailed explanation of this procedure follows.

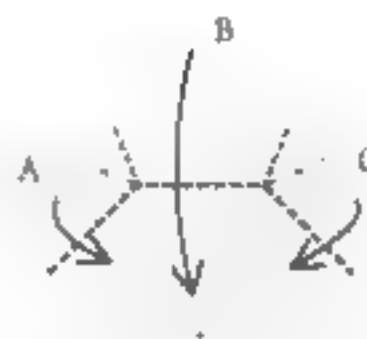
*Location of second sink (inward)*



*Location of first sink (inward)*



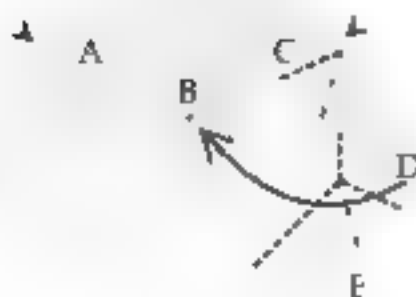
*Location of third sink (inward)*



12a. Untold the model completely. Note the locations of sinks to be executed. Turn the paper over.

12b. Bring the three points in to the center on the existing creases, (folding the sides first (A & C), and then the top (B). Don't worry about the lighter lines, just do the dark portions and the others will follow naturally

*Note: The creases on the sides will only come as far as the arrows indicate. The model is shown flat to clarify the folding procedure but is actually 3D.*



12c. Bring the next two points D and E to the center, as in step 12b.

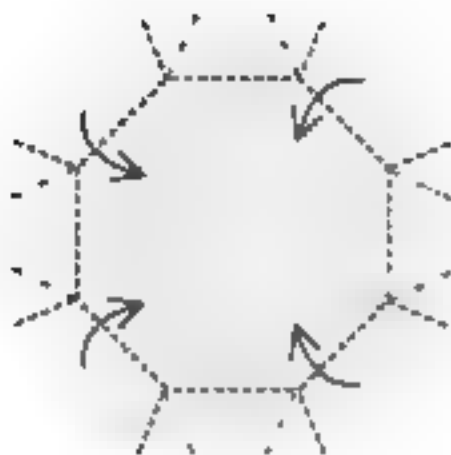


12d. Continue around the circle with the remaining points.

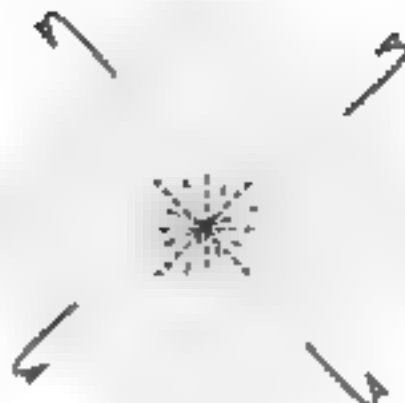
12e. Turn the model over







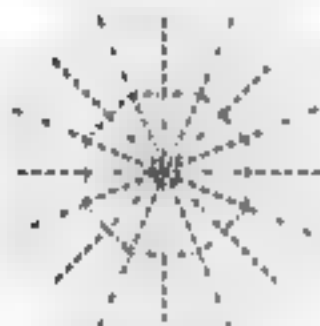
11 Repeat the process on the next layer of folds, letting the flaps swing out from behind.



12 Now, to complete the first two layers of the sink, fold the model up like a fan on the existing creases.



12a The first two layers of the sink are completed.



13 The last sink is done in a similar way, but not flat. Open the model as shown, and work it back together one flap at a time, creasing each of the short lines on the inner octagon, moulding the paper inside the octagon downward, and the paper outside the octagon upward.



13a Third sink completed



14 This is an X-ray view showing the inside of the model. Fold the side flap inward...



15 ...and fold the extra back



16 Repeat the fold on the other side.



17 Repeat these inside folds on the back and sides.



18. Prepare to double petal fold. Fold the flaps in and unfold.



19. Petal fold on the creases.



20. Fold and unfold



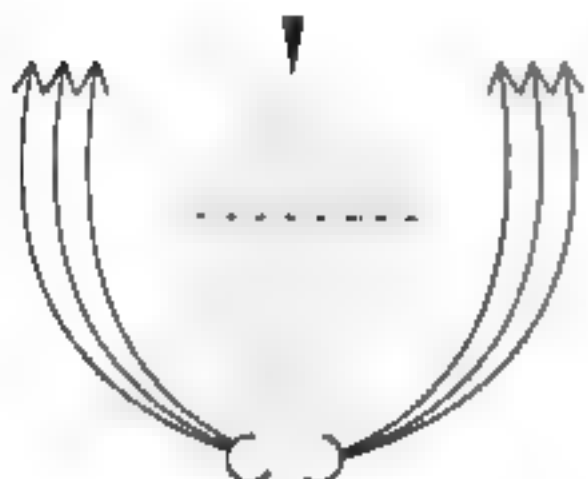
21. Now petal fold in the opposite direction.



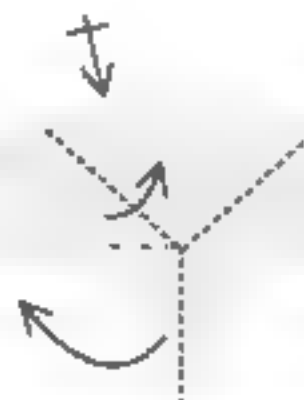
22. Repeat the double petal fold on the remaining three flaps



23. Completed eight flapped bird base. This base is different from the one described in the basic section. Fold one flap in front to the right and one flap behind to the left. The sides should be one smooth surface, with no split down the middle.



24. Stretch the base, bringing three flaps up on either side



25. Like this. Rabbit eat the flap to the left repeat behind.



26. Push the entire assembly inward. The outside flaps will reverse, and the center flap will go deep inside the model.



27. There will be two full sized flaps on the sides, and one half sized flap to the rear in the center. Perform two sinks simultaneously, to reverse the rear flaps so that all the flaps are forward.

28. Valley fold the front leg. Repeat behind.



29. Make an odd reverse fold, approximately 1/3 up and 2/3 down the total length of the leg, opening is just slightly at the bottom. Repeat behind.



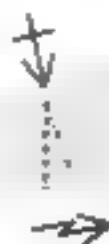
30. Reverse fold to create the foot. Repeat behind.



31. Reverse fold again to complete the foot. Repeat behind.



32. Round the leg slightly by pinching from either side. Repeat behind.



33. Inside crimp fold the back leg; one of the creases is already in place. Repeat behind.



34. Fold the tip of the leg to the top and unfold. Repeat behind.



35. Inside reverse fold again to create the lower leg. The lower crease was made in the previous step. Repeat behind.



36. Turn the leg slightly by folding down from the top corner through the middle crease slightly less than half way across. Repeat behind.



37. Repeat steps 30-31 on the rear legs. Repeat behind.



38. Mountain fold the lower part of the back leg to make the width approximately even along the entire length. Repeat behind.



39. Give the legs their final shape by pinching between thumb and index finger. Repeat behind.



40. Crimp fold the tail into place. The hidden mountain fold line is shown outside.



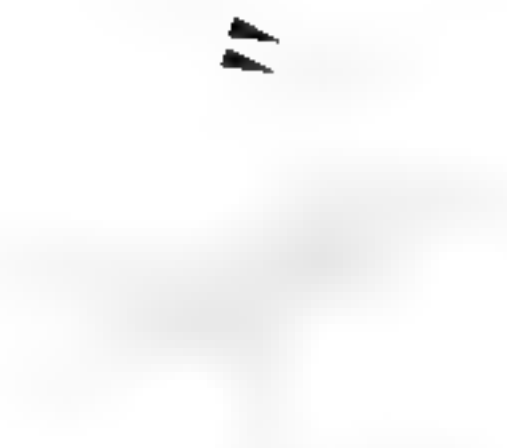
41. Thin the tail with two reverse folds.



42. Continue shaping the body by making a thinning fold on both sides of the back from the frontmost corner to the middle of the rump, and two more to thin the tail further. Also, shape the bottom of the chest by crushing and rounding the belly area.



43. Reverse fold the first head downward. The crease is just slightly above the base of the neck, and the finished fold will be just slightly above parallel.



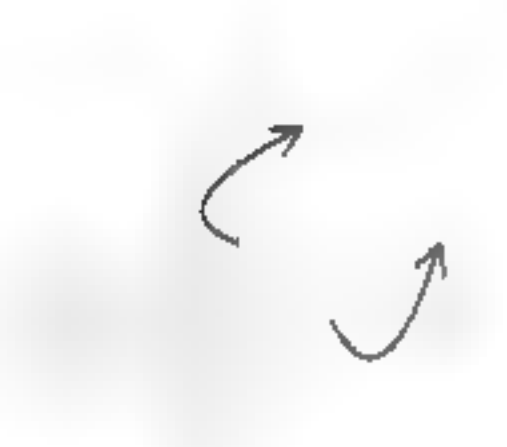
44. Note the orientation of the flap. Now, reverse fold the other two in the same way.



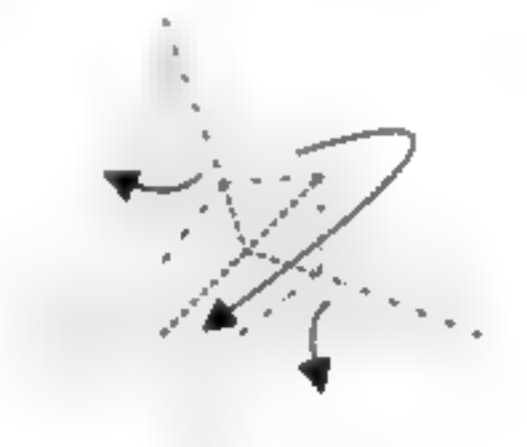
45. Pull down a single (white) layer of paper from the back of the nearest head. Note the orientation of these flaps very carefully, you will have to put them back into place later. Repeat behind.



46. The white regions on the heads are on two single layers of paper. The next several steps will reverse the orientation of these layers so that all the heads are colored, and are less encumbered. Open the front of the model slightly.



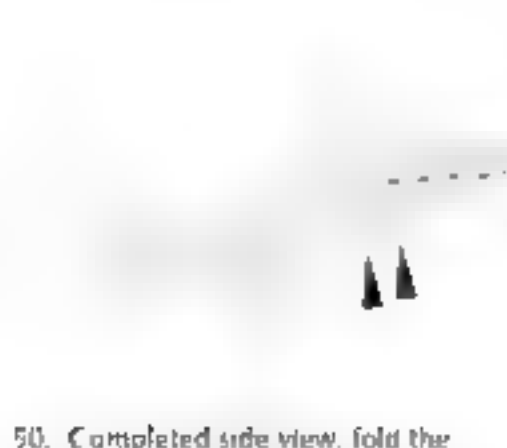
47. This is a partial view of the top of the model. Note the location of the colored and non-colored regions. Carefully unfold the upper, non-colored region.



48. Now, fold the paper back up on the existing creases, reversing the direction of the folds as shown. This sequence will wrestle with you, but will finally fall into place easily.



49. Repeat the inversion on the other side.



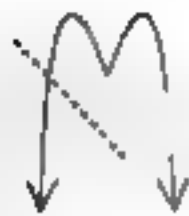
50. Completed side view, fold the flaps back up inside, exactly where they were in step 45 before you pulled them down for the inversion.



51. Mountain fold to create the neck. The bottom of the line lies just slightly forward of the top. Repeat behind.



52. Sink the two double layers of paper in angularly.



53 This is a close-up view of the head. The following directions for the head are very specific and not often well landmarked. Pay very close attention to the directions as well as the placement of lines in the drawings. Outside reverse fold downward.



54 Crimp fold back up and collapsing inward to form the ears. The top of the head should be perpendicular to the front of the ears.



55 Valley and mountain fold all layers of the head as shown. Note that the mountain fold is not flush with the forehead.



56 Crease the creases.



57 Crimp on the creases. This is a lot like a sink, but can be done if you are aggressive about it.



58 Reverse fold the tip at the nose. The bottom should be just slightly closer to the body than the top.



59 Fold a final flap of paper inside on either side to complete the jaw. Note that there are two lines on the fold, not one. Sculpt the back of the head, as before with the body.

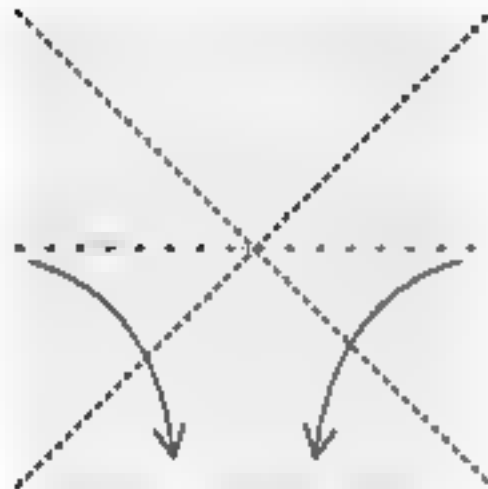


60 One head completed. Repeat steps 53-59 on the other heads.

61 Completed model.

## Stylized Pegasus

I created this model so I would have examples of what could be folded from an eight sided bird base. I designed three models that had eight appendages each: "Cerberus" four legs, three heads and a tail, the "Hydra" five heads, two wings and a tail and "Pegasus" four legs, two wings, a head and a tail. I chose to go with a stylized look for "Pegasus" because there are so many versions already in existence. I thought a simple one would be nice. Unfortunately the eight sided bird base rates a higher level of difficulty than I expected. The model can be folded from any type of paper. A 10" sheet of paper produces a model 5" in length.



1. Start by creating a waterbomb base, white side out.



2. Fold and unfold the top.



3. Fold the flap upward bringing point A to the center line.



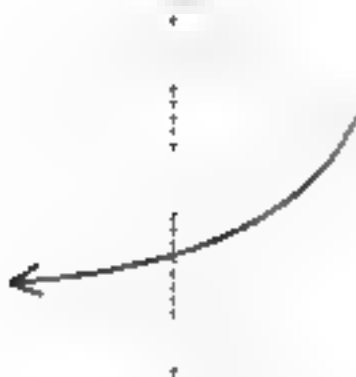
4. Fold the flap back down.



5. Crimp inside on the creases.



6. Repeat the crimp on the other three flaps.



7. Fold one flap to the left.



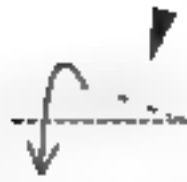
8. Fold and unfold.



9. Sink the six sided area.



10. Fold and unfold.



11. Fold two flaps down causing the right side to spread out.



12. Fold the flaps back up.



13. Fold the flap back.



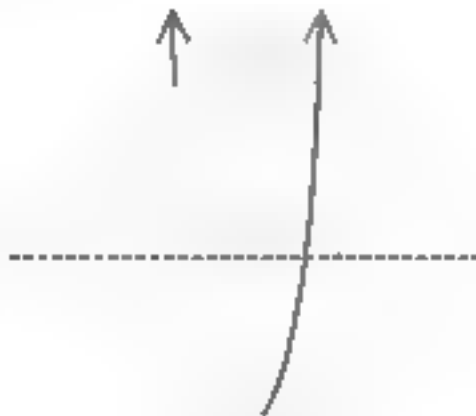
14. Fold one flap upward, repeat behind.



15. Fold one flap to the right, repeat behind.



16. Fold one flap to the right, repeat behind.



17. Fold one flap upward, repeat behind.

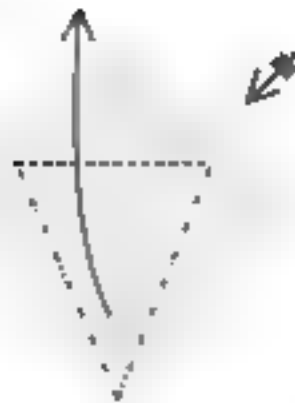


18. Rotate 180 degrees.





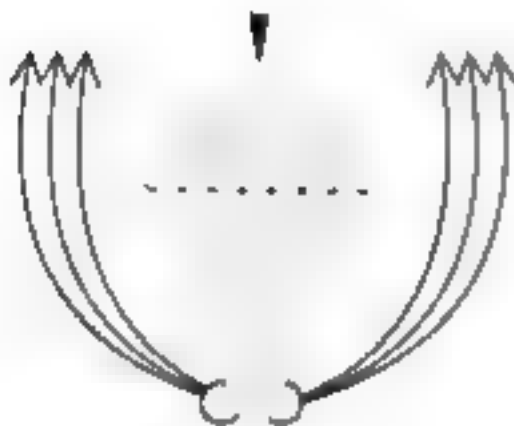
19 Reverse fold the four flaps being extremely careful to keep the inside layers flat as if there were no continuous square



20 Completed eight flapped preliminary base. To create an eight flapped bird base, petal and each of the flaps as with a regular bird base.



21 Completed eight flapped bird base. Fold one flap in front to the right and one flap behind to the left. The sides should be one smooth surface and not have a split down the middle.



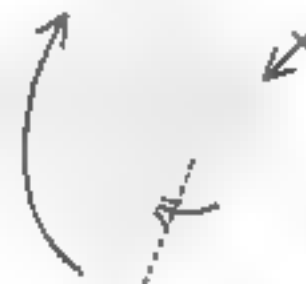
22 Stretch the base, bringing the flaps up on either side



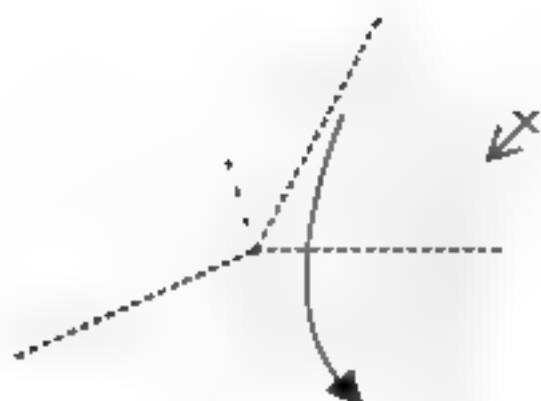
23 Like this. Push the middle point inward, reverse folding, allowing the outside flaps to open slightly



24 Fold the flaps inside.



25 Fold the wing upward, the 'reverse fold' on the leg will follow automatically. The back leg will also unfold, but don't worry about it. Repeat behind.



26. Fold the wing back down, putting the creases on the back leg as they were. Repeat behind



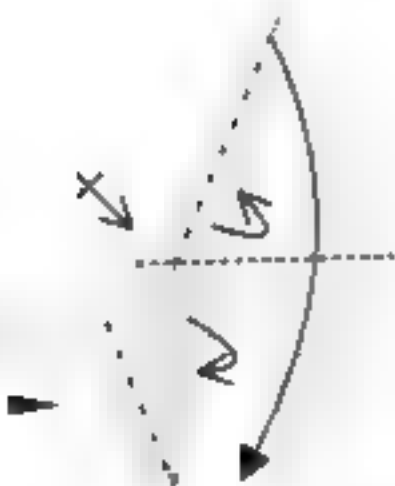
27. Reverse fold the head.



28. Fold the legs down.



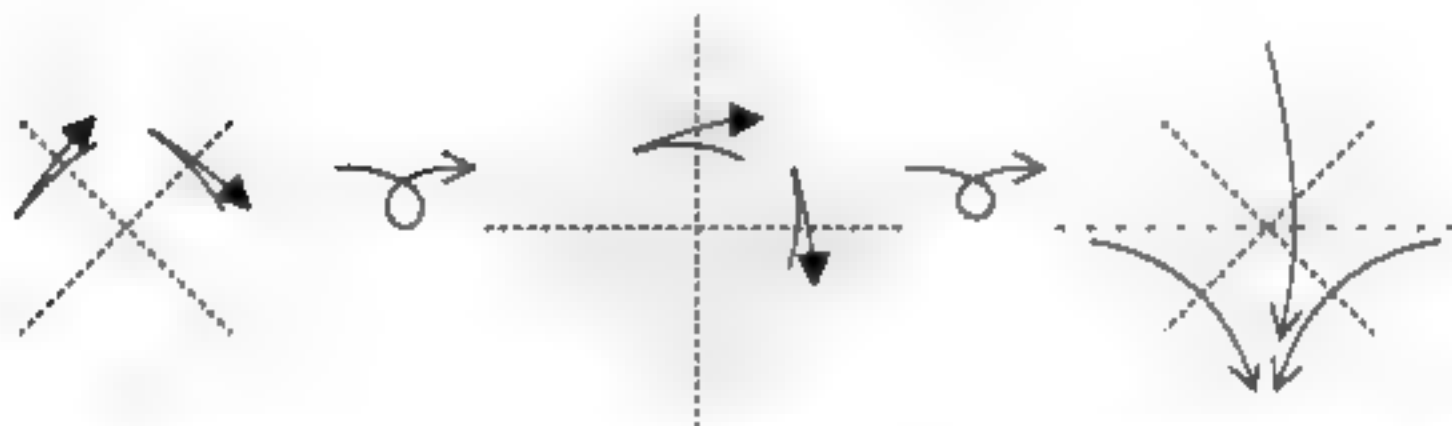
29. Pull the wing up again, allowing the loose paper from the inside of the back leg to pull out. The model will not lie flat.



30. Thin the leg by reverse folding the back half, and then folding wing back down, tucking a single layer of the wing inside itself, and throwing the front of the leg at the same time. Repeat the last two steps behind.

31. Completed model.

**Loch Ness Monster** - This model was originally an experiment in trying to put teeth on a simple head such as the one found on the traditional crane. After successfully creating the teeth, put the model aside thinking that someday I might add a tail and feet and claws. Later I decided that the model was worth including as it is, as an example of origami that is stylized and merely suggestive of its subject, rather than deluged in accuracy. The model can be folded from any type of paper. A 10" piece of paper produces a model approximately 6" in length.



1. Fold and unfold laterally  
Turn the paper over

2. Fold and unfold diagonally  
Turn the paper over.

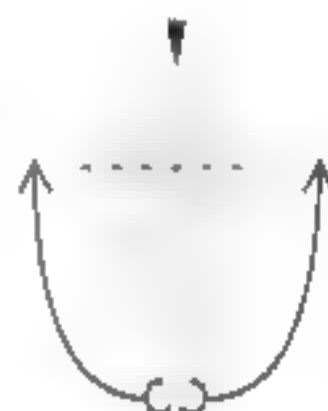
3. Bring all four corners together forming a preliminary base on the existing creases



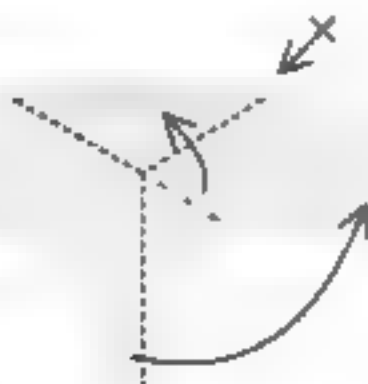
4. Pull up fold the front and back flaps



5. Fold the two flaps back down



6. Stretch the birdbase by grabbing one flap on either side of the model and pulling them to the sides causing the top area to flatten



7. Completed stretched birdbase  
Rabbit ear the two flaps.



8. Outside reverse fold the point



9 Mountain fold back of the flaps



10 Outside reverse fold the head.



11 Pinch the top to make a crease. Repeat behind.



12 Open the flap up as in step 1 and swing the back flap of the net.



13 Fold the point downward while opening the flaps.



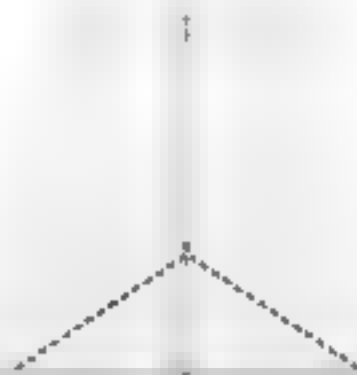
14 This is an enlarge of partial view of the head of the model and the flap in half, and then inside the model.



15 Swive fold to thin the bottom of the triangle.



16 Spread squash the points to thin the tops of the teeth.



17 Fold the model back up as in step 1.

18. This model, like the diving duck, is not complete unless it is sitting on a table: the rest of the lizard is under the water!

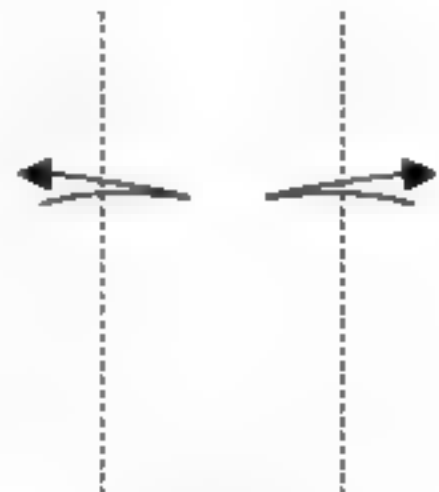
**Braided Paper** - This model was created accidentally while I was working on the "Frost Dragon", while I was trying to come up with a way of creating a structure that would allow me to integrate the head of the dragon with the rest of the model. While I was fiddling with the paper I created this model up to step 24 with all the flaps sticking out all over the place. I braided them together just to get them out of the way. This model can be folded from any type of paper. A 10" sheet of paper produces a model 3 3/4" wide.



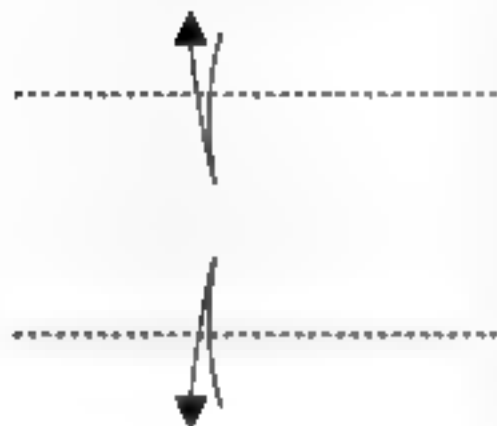
1. Fold and unfold.



2. Fold and unfold.



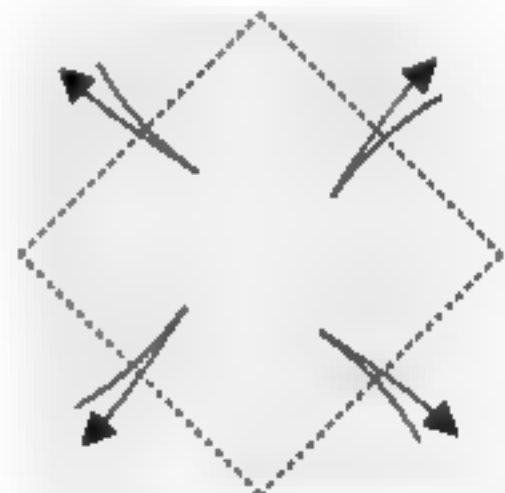
3. Fold and unfold.



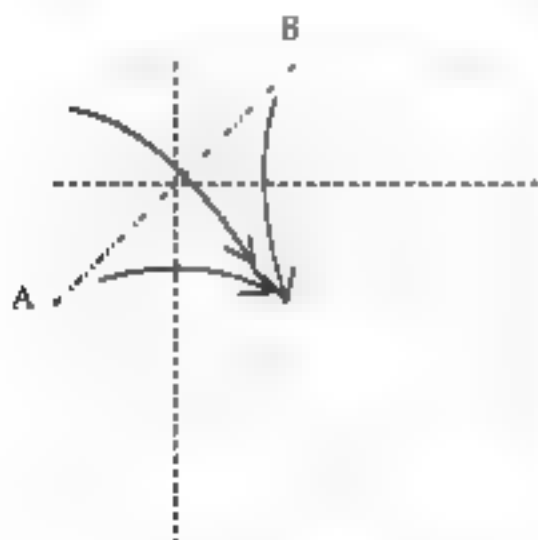
4. Fold and unfold, turn the paper over.



5. Like this.



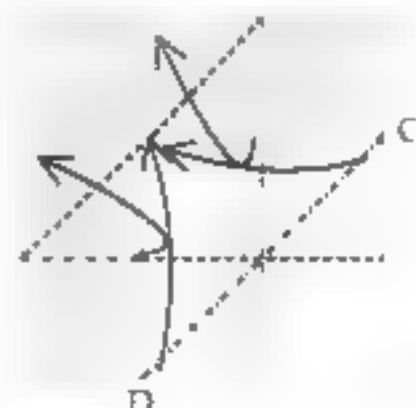
6. Fold and unfold all four corners. Turn the paper over.



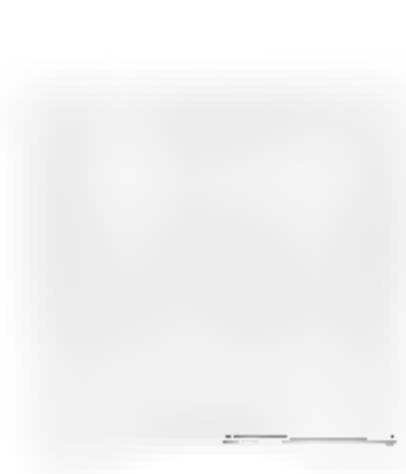
7. Following the existing creases, bring points A and B to the center.



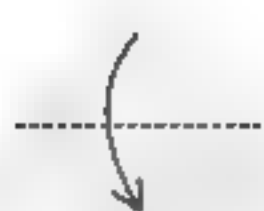
8. This is a mid-fold view.



9. Repeat step 7 on C & D.



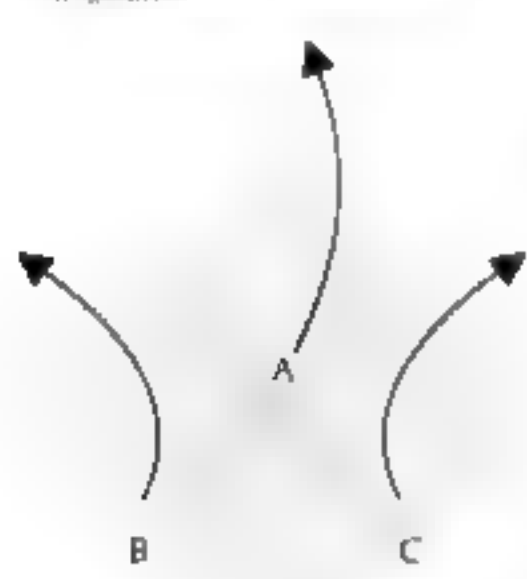
10. This is a completed windmill base. Rotate the model 45 degrees.



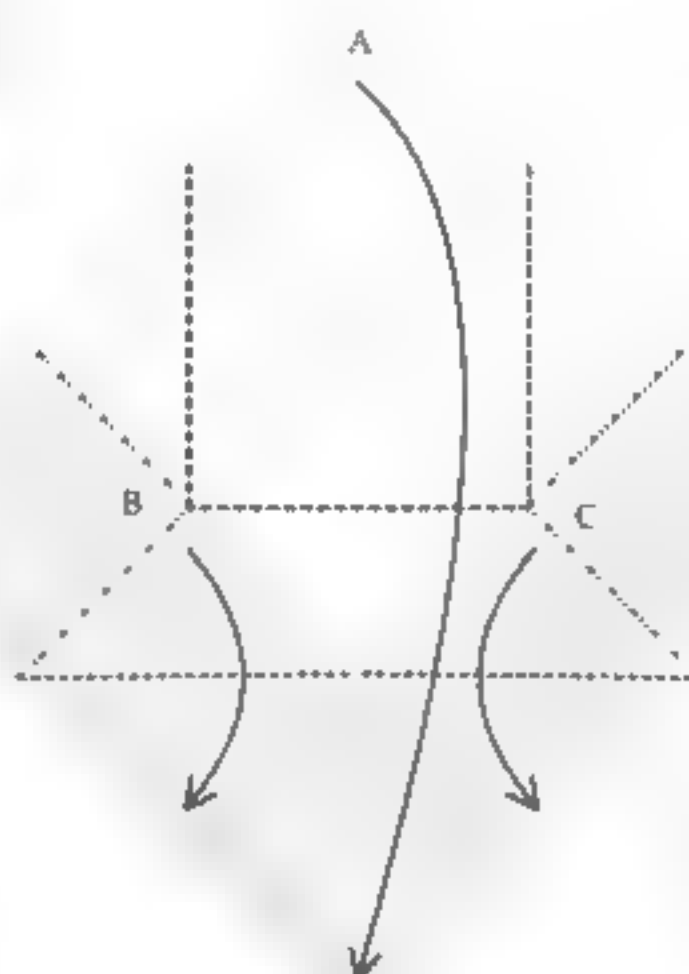
11. Steps 11-13 show the correct way of executing an open sink on the top corner. When you are comfortable with the sequence, steps 13-15 will be executed as one step without flattening the model. If the sequence confuses you, see the additional explanation in the "Techniques" section. Fold all layers to the center.



12. Fold the layers back up.



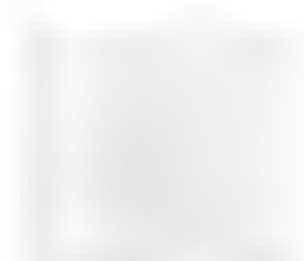
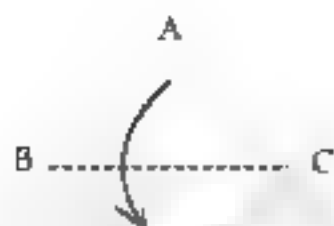
13. Pull flap A all the way upward, opening out B & C.



14. Fold back up on the previous creases, but turn the three lines of the completely opened flap (shown bolded) inside out.



15. Complete the sink by folding point A back into place, pulling the side flaps inward as you go.



16. Fold the flap down.

17. The first sink is completed. Repeat steps 11-16 on the three other flaps. The folds will become more complicated as you go because you will not be able to open to model completely.

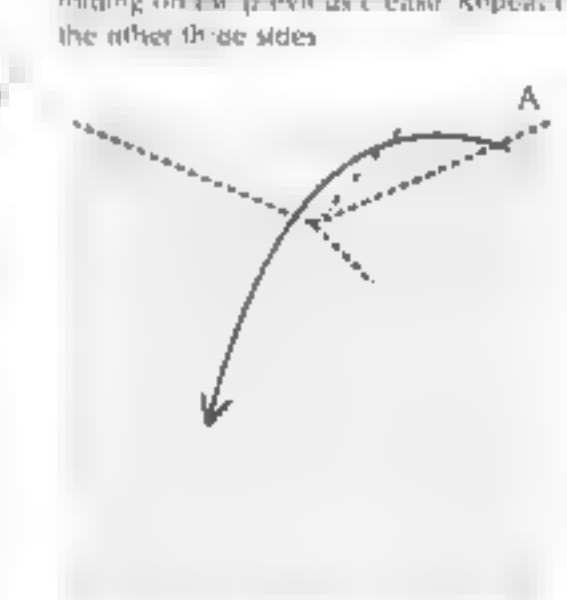
18. The first layer of sinks is completed.



19. This is an X-ray view. Reverse fold the two flaps in half. Repeat on other three sides.

20. Steps 20-23 will demonstrate how to pleat-sink the two triangular areas. Unfold the flaps. Repeat on the other three sides.

21. Crimp fold the flaps, mount in folding halfway between the previous crease and the diagonal, and valley folding on the previous crease. Repeat on the other three sides.



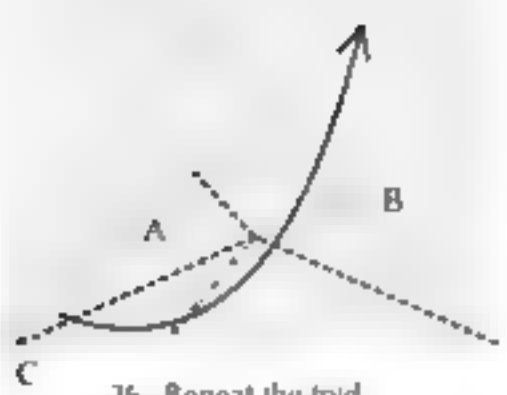
22. Reverse fold the two flaps. Repeat on the other three sides.

23. The pleat-sinks are completed.

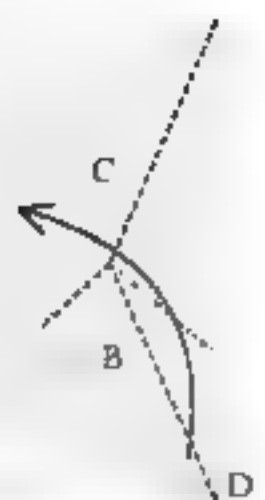
24. This is no longer an X-ray view. Pull point A down as far as it will go, pinning the sides as you fold.



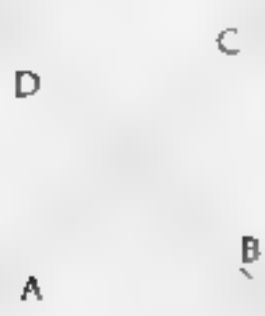
25. Repeat the fold on the next flap. Point A will become covered.



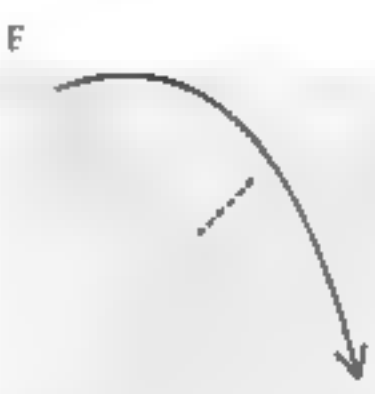
26. Repeat the fold on the next flap.



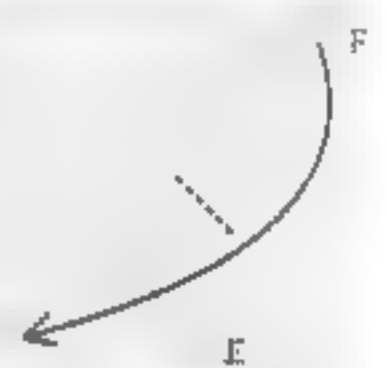
27. Repeat on the last flap, tucking point D inside the model.



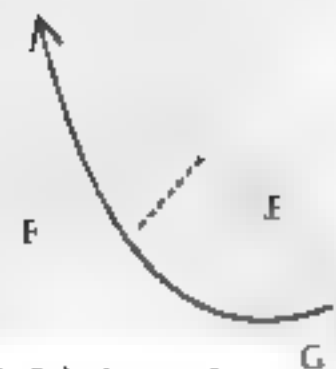
28. The first layer of brads is complete.



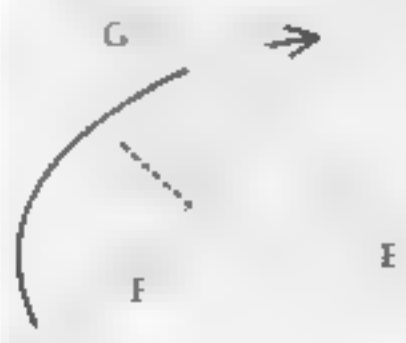
29. Fold the flap down...



30. ...and the next flap so that it crosses the flap folded in step 29.



31. Fold the next flap.

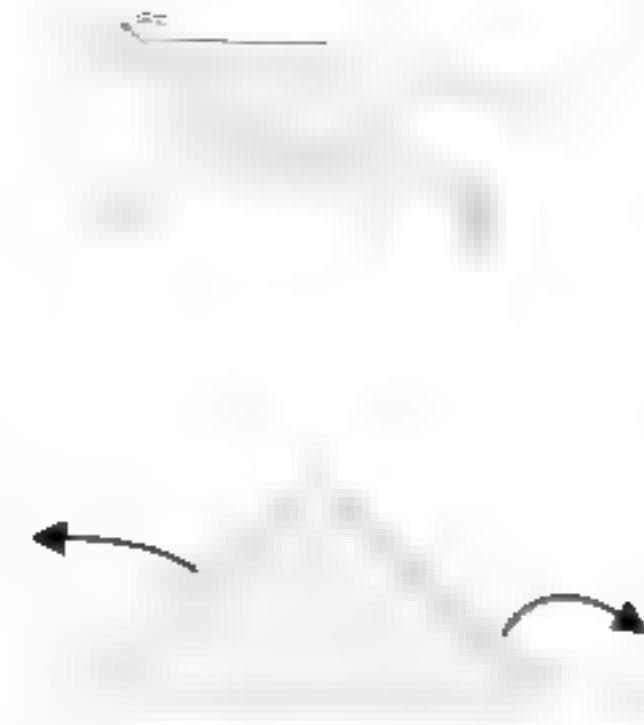


32. ...and the final flap, folding over the last flap, under the first and out the other side.

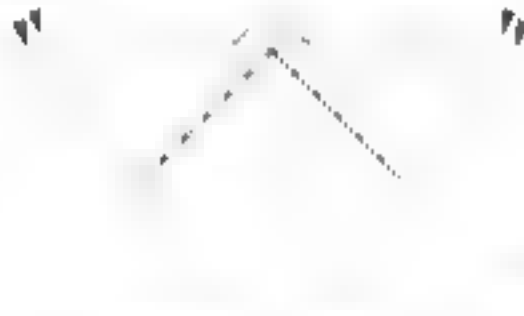
33. Completed model.



**Frost Dragon** - This model was created using the piecemeal approach. That is, each part was created separately and then integrated with the rest. The integration is a very difficult and unnerving process. It is folded from an eight sided waterbomb base. If you have never folded it, I strongly recommend that you start with a cheater base and do not fold the model from the folded version until you are comfortable with the sequences. Start with a very large piece of extremely thin, foil backed paper, such as tissue foil or Japanese foil. A 24" cheater base will produce a model 16" long. A 48" piece of paper will produce a 24" folded base.



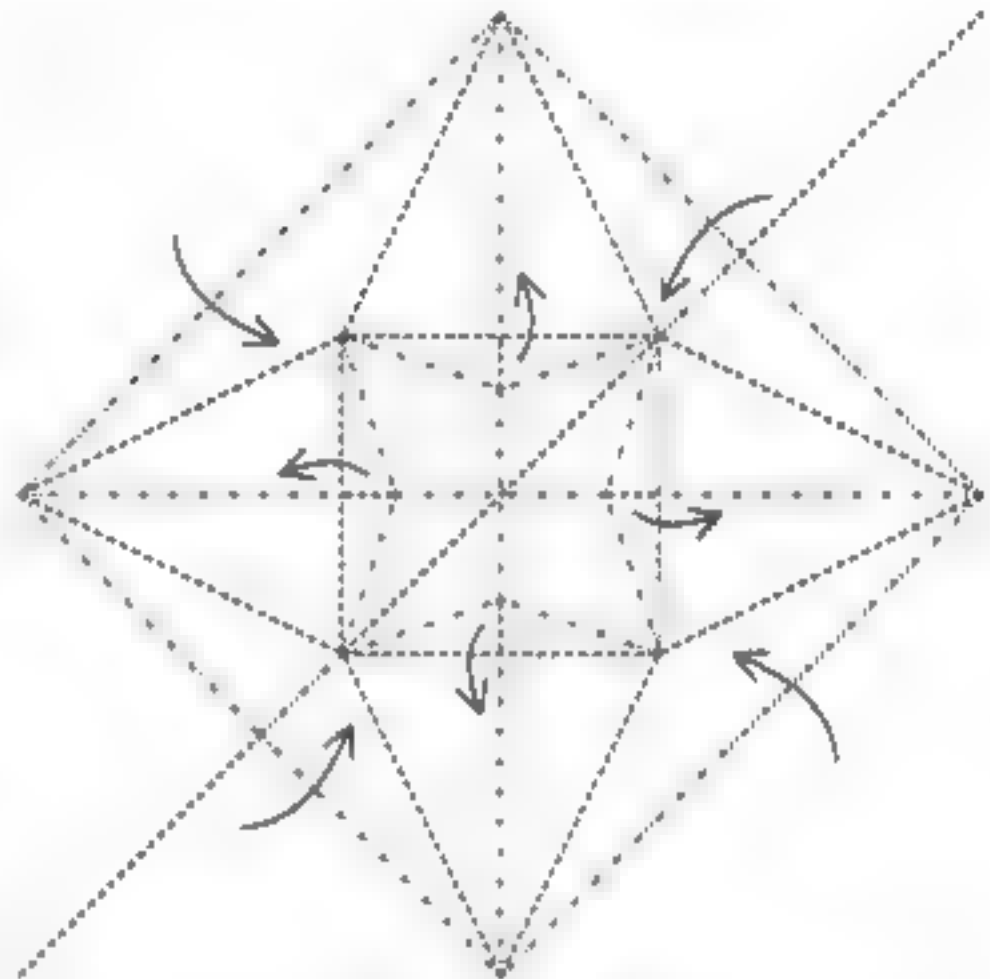
1. This model is folded from an eight sided waterbomb base. If you have never folded the model, it is recommended that you use a cheater base. If this is the case, proceed to step 6. If you are using the folded base, then unfold the paper completely. Directions for both bases can be found in the "Bases" section.



2. Reverse fold the four flaps being careful to keep the insides layers flat and evenly distributed. These folds will cause the paper at the top to be pulled asymmetrically downward.



3. Turn the preliminary base into a waterbomb base by turning the entire model inside out keeping all internal structures flat and intact.



4. With the white side up, collapse the paper on the modified creases.

5. This special version of the eight sided waterbomb base will allow the model to be folded without any "breaks" in any of the external surfaces.

5  
6  
7  
8

4  
3  
2  
1

6. Each of the eight flaps will be referred to by number, starting with the right front flap, and moving counterclockwise. Each flap will become a major appendage of the model. Flaps 1 and 3 will become the front legs, flaps 4 and 6 the back legs. Flap 2 will become the head, and flap 6 the tail. Flaps 7 and 5 will become the wings. If you are working with patterned paper you might want to strategically choose which flaps will become which appendage, particularly the pattern which will appear on the wings.



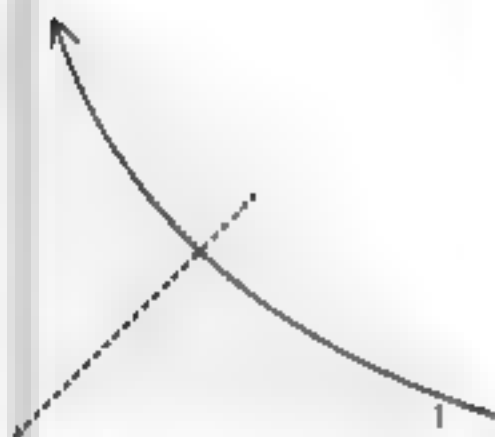
From here on the end of the model, no directions will show the simpler, cheaper base, to simplify the drawings. Carefully fold and unfold the entire base in half, creasing lightly.



8 Crease lightly again at 7-4



9 Crease again very sharply at 1-8 bringing the first crease to the second crease. This crease is very important but will not be used until much later. If you are not using foil, you might want to mark the crease lightly on the edge of the paper with a pencil.



10 You are now working on flap 1. Fold the flap upward.



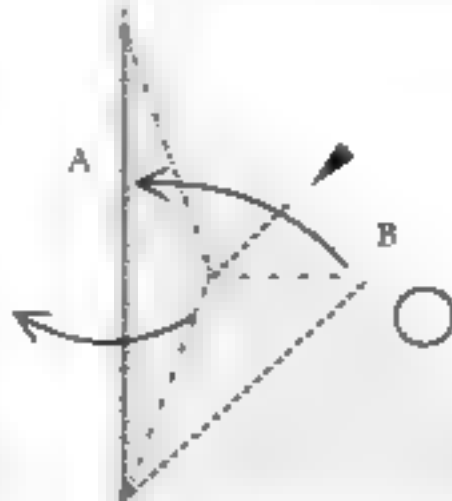
11 Very accurately fold a rabbit ear through both thicknesses



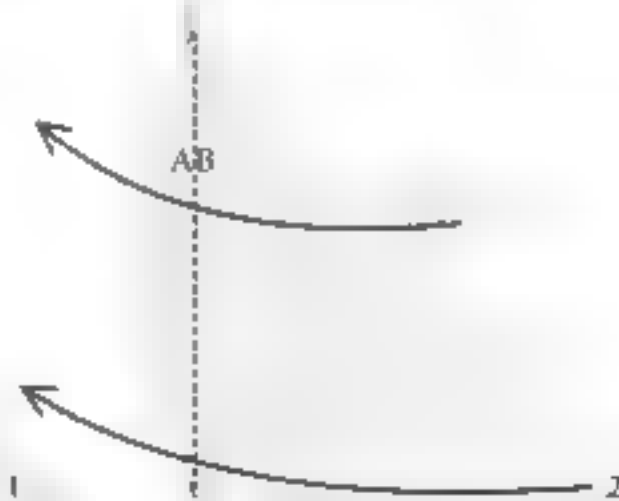
12 Fold the flap down and back up



13 Untold the flap,



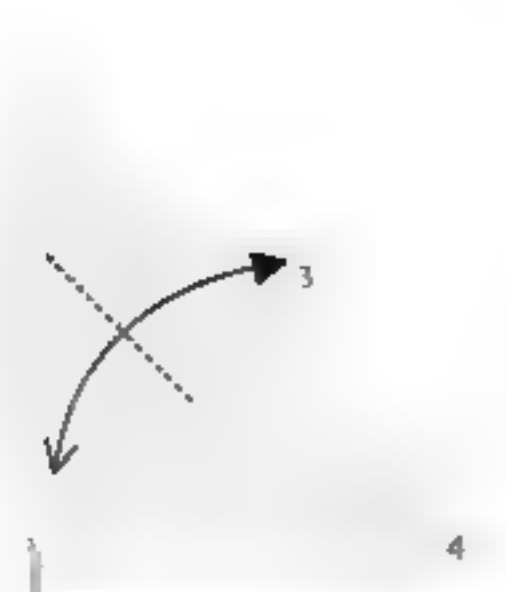
14 Fold a double rabbit ear on the flap. Grasp the flap where indicated, and squash fold the top half of the flap bringing B to A. All of the creases are already in place.



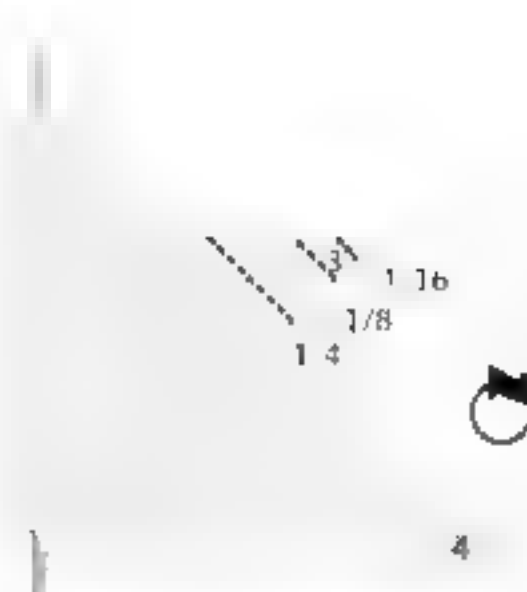
15 Fold flap 2 to the left



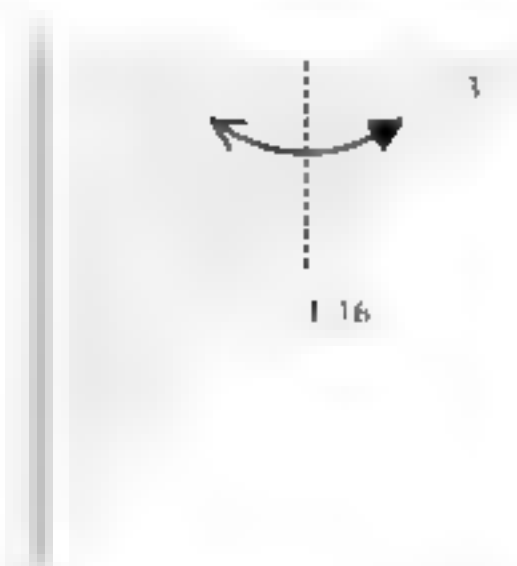
6. Repeat steps 0-4 on flap 3.



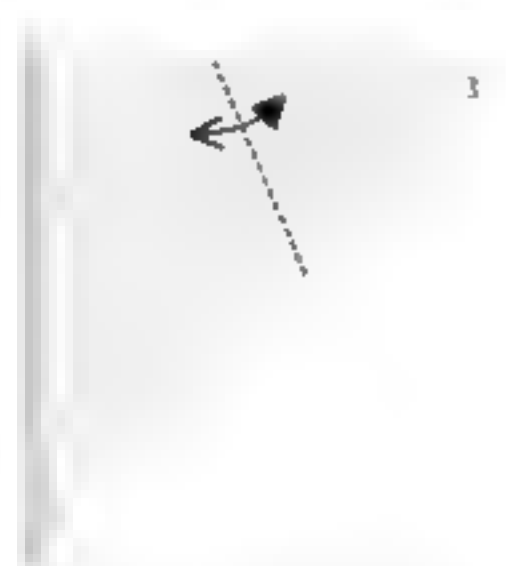
17. Fold the flap in half, and unfold.



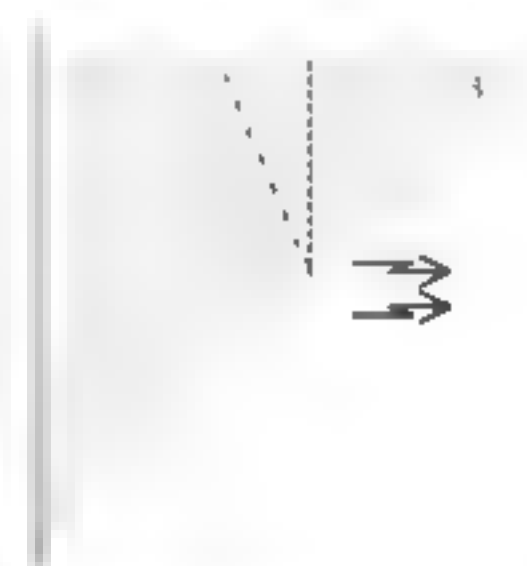
18. Fold the flap three more times, to mark 1/4, 1/8 and 1/16.



19. This is an enlarged view of the tip of flap 3, showing only the crease at 1/16. Fold and unfold where indicated.



20. Fold and unfold, matching up the vertical and diagonal creases.



21. Inside crimp fold on the creases.



22. Reverse fold the flap in half.



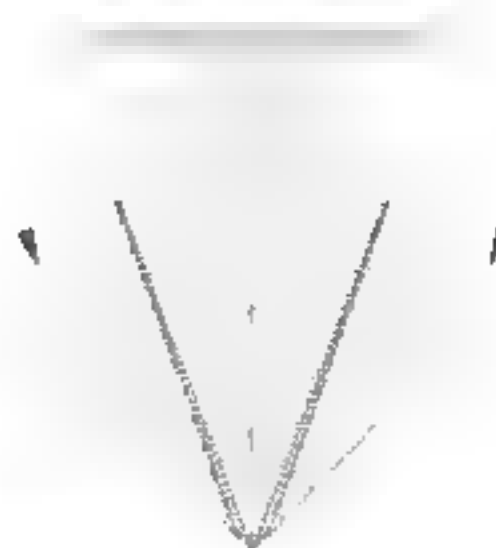
23. Reverse fold the two small flaps.



24. These two illustrations show the resulting structure. This structure will later become the claws on the feet.



25. Squash fold the flap, allowing the claw creases to open completely.



26. Execute two asymmetric reverse folds, adjusting the top set of lines so they come not to the tip of the square, but to the edge of the claw creases. The lower hidden lines will come to the tip of the square.



27. Fold one flap to the right.



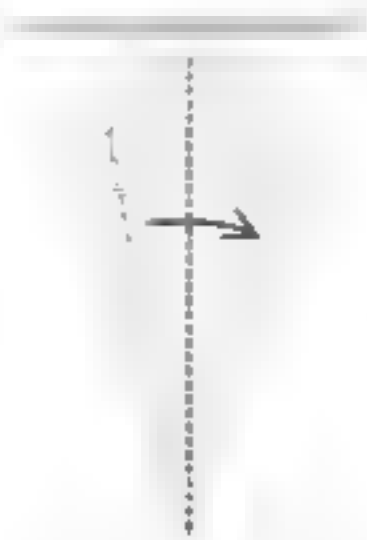
28. Fold the flap in half along two vectors, the top one intersecting the bottom tip, and the hidden one intersecting the edge of the claw, as in step 26.



29. Like this. Unfold the flap.



30. Pleat-sink on the creases.



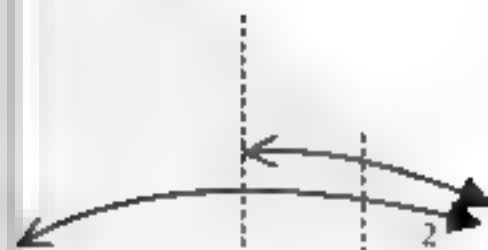
31. Fold the flap back to the right.



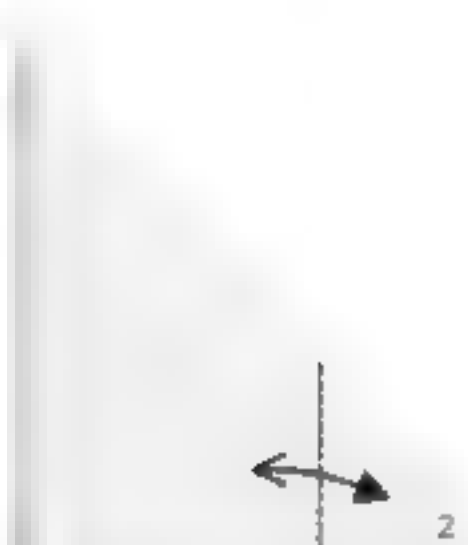
32. Repeat steps 27-31 on the left.



33. Repeat steps 17-32 on flap 1.



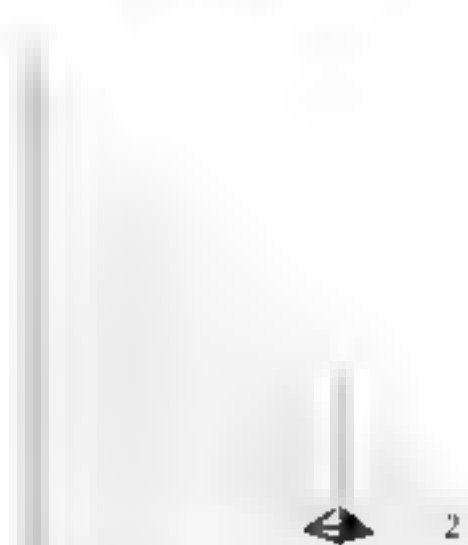
34. You are now working on flap 2. To make the head, the flap must be marked at  $11/32$ nds. Fold the flap at  $1/2$  & unfold, then at  $1/4$  and unfold.



35. Mark  $1/8$  by bringing the  $1/4$  line to the  $1/2$  line.



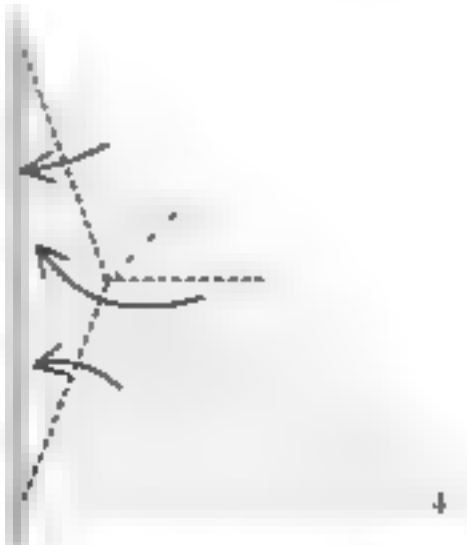
36. Mark  $5/16$  by bringing the  $1/4$  line to the  $1/8$  line.



37. Finally mark  $11/32$  by bringing the  $5/16$  line to the  $3/8$  line. Crease very sharply, and unfold.



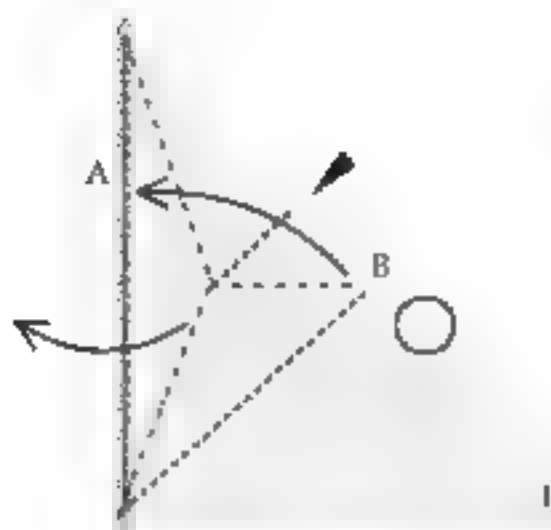
38. Fold the flap diagonally on the  $1/32$  line.



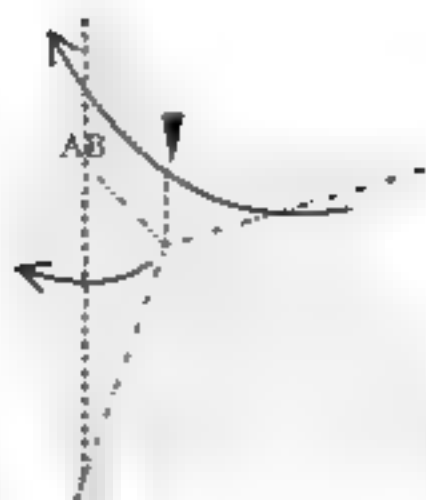
39. This is a closeup of just the area around  $1/32$ . Fold a rabbit ear very accurately through both layers.



40. Fold the flap down and back up, then, unfold to step 38.



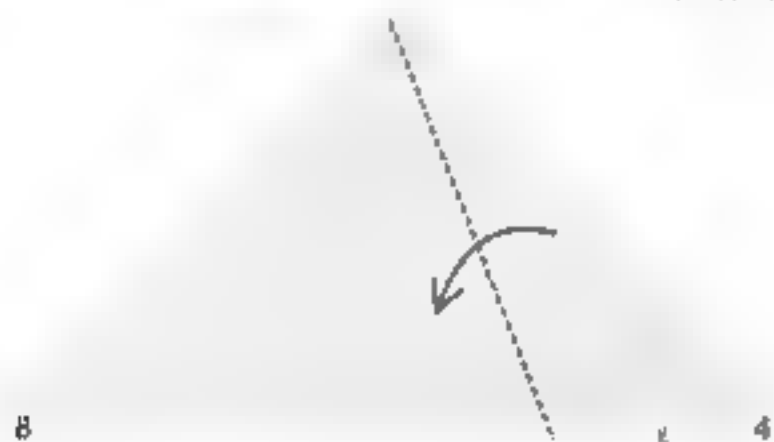
41 Fold a double rabbit ear on the flap.



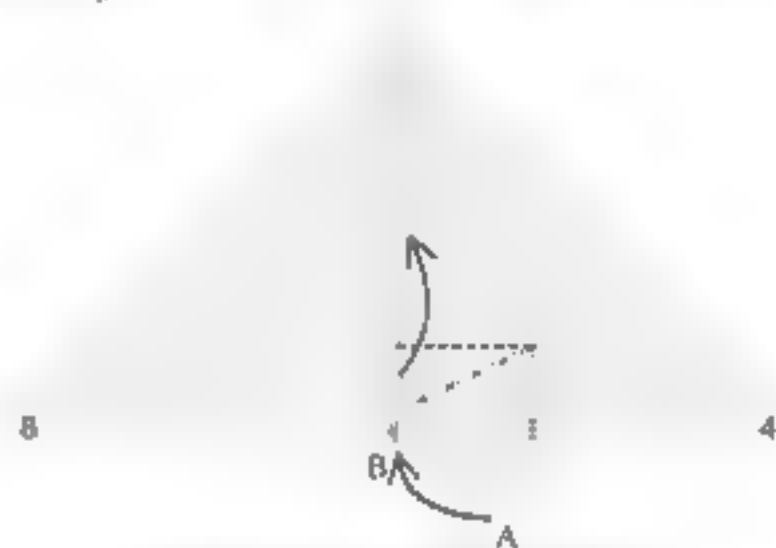
42 Fold another double rabbit ear on the other half of the flap.



43. Like this. This is a quadruple rabbit ear



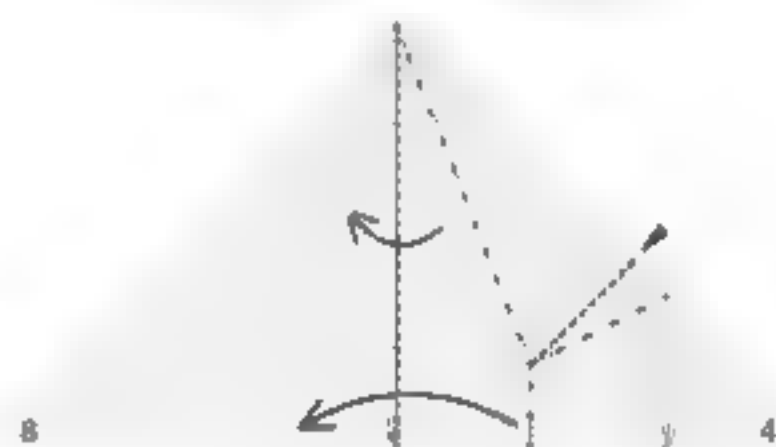
44 Fold the flap to the center.



45 Swing the flap up, bringing point A to B. The dotted line shows a hidden valley fold.



46. Unfold to step 44.



47 Squash fold the flap on the creases as indicated.



48 Like this.



49. Fold the flap along the diagonal, very accurately.



50 Carefully fold the flap back along the horizontal.



51 Fold the flap a final time



52. Unfold the flap to step 49.



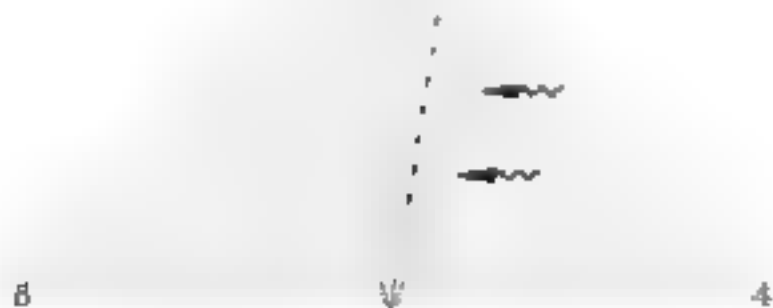
53. Crimp on the creases.



54. Reverse fold the remaining flap.



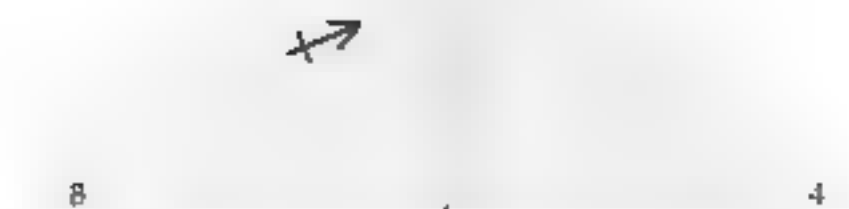
55 Repeat steps 49-54 on the other side.



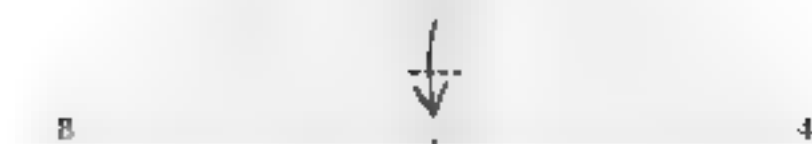
56 Pleat sink the large flap and the smaller hidden flap through a total of four layers, but leave the bird base on top intact.



57 Sink the the top flap, but not the remaining one underneath



58. Repeat steps 56-57 on the other side



59. Fold the top layer of the head down into place



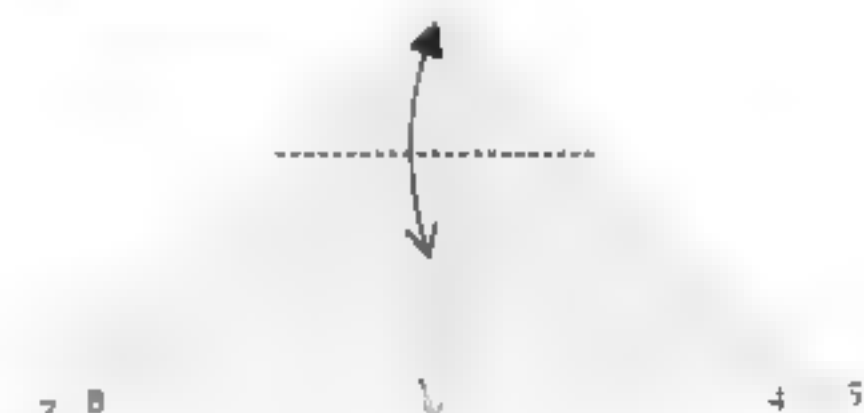
60. Locate the 1/8 line on flap 4



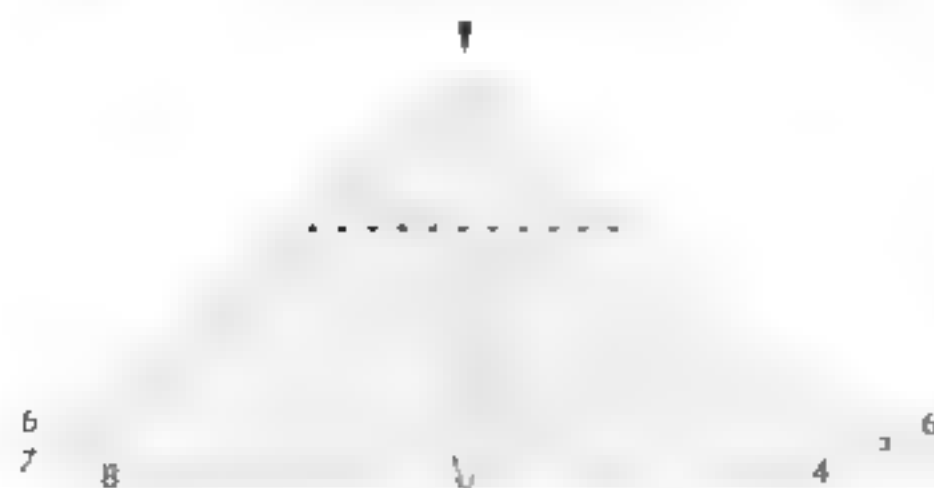
61. Execute the claw sequence, steps 19-24, on flap 4 on the 1/8 crease



62. Repeat steps 60-61 on flap 8



63. Fold and unfold at 3, 8, to reassert the crease made in step 9



64. Sink the five sided area located at 1/8, treating the entire front surface as one plane. This is rather difficult.

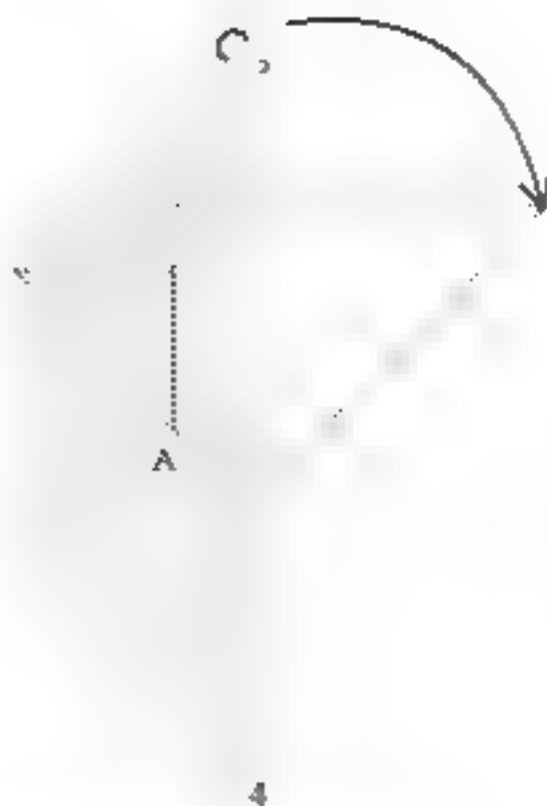


65. Swing flap five behind from the right to the left. Turn the model over.





66. Reverse fold two of the three hidden flaps, as deeply as possible.



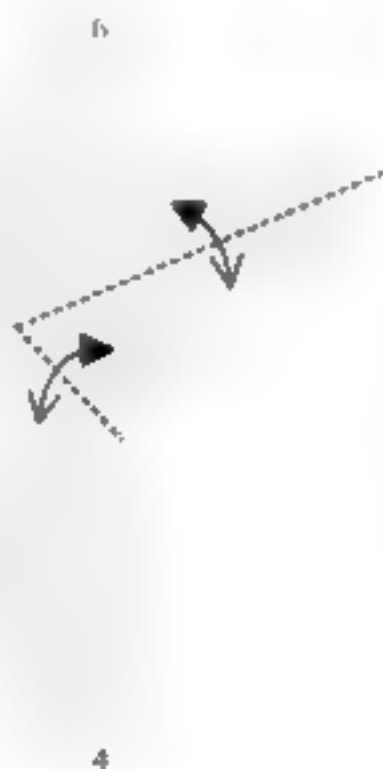
67. Grasp the middle flap and slide it down into position using point A as the pivot. The dotted line shows the correct final position.



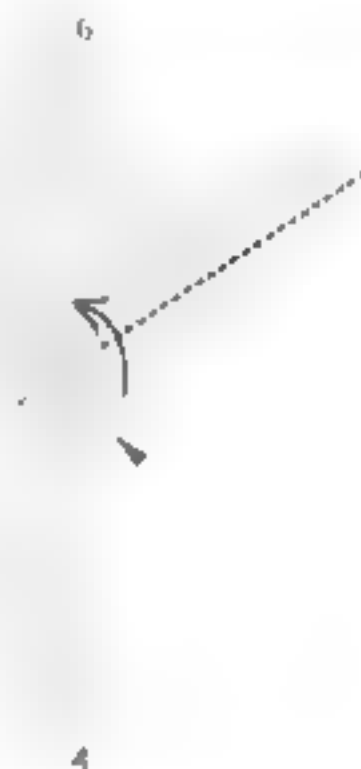
68. Reverse fold the two hidden flaps as far forward as they will go.



69. The dotted line shows the correct final position. Fold the wing downward. It is normal for the front edge of the wing to fall below the vertical center line.



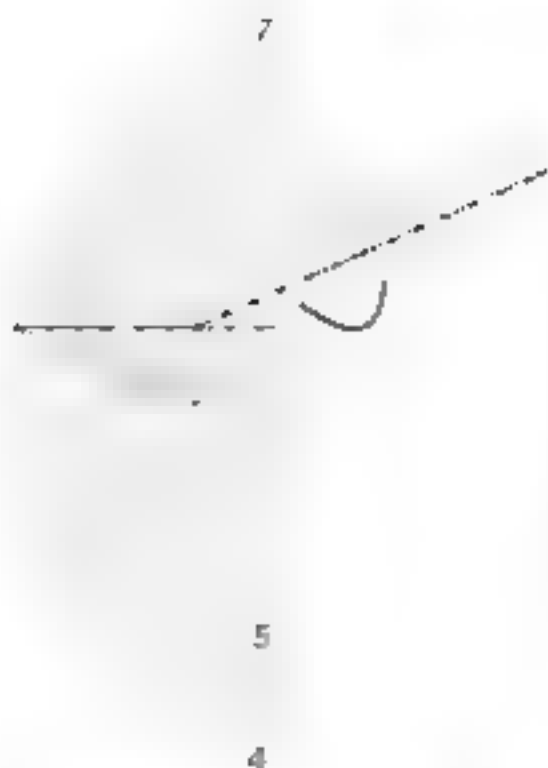
70. Fold and unfold, first the right triangle, then the long edge.



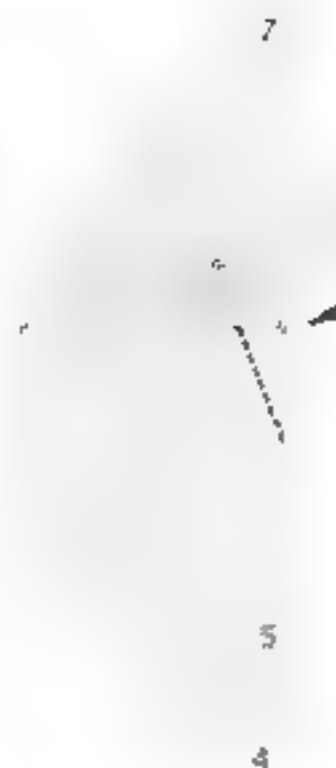
71. Reverse fold the flap in half, lining up the hidden crease with the corner of the right triangle.



72 Fold and uncrease the entire tail sheet down and back up.



73 Mountain fold the structure upward, including the large area that is inside the wing. When complete, arrange the flaps on the inside so that the model lies flat.



74 Reverse fold the flap in half as far as it will go.



75 Valley fold the flap in half as best as you can, then tuck the entire flap underneath. Some loose paper will try to pull down from above, gently push it back into place as you flatten out the model. The structure inside is unimportant. Completing the fold "correctly" requires a curved spread squash, the point is to hide the paper at the corner inside of the model.



76. Like this.



77 Fold the wing back up.



4

78. Repeat steps 69-77 on the other side.



4

79. Fold the wing back down.



4

80. Fold and untuck the tail in half.



4

81. Clamp sink the entire tail structure downward through the center of the model. The sink is symmetric about the center of the model. Keep the folds close to the center and be careful not to encumber any unrelated structures, particularly the wing.



4

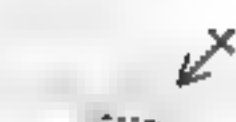
82. The tail is now in its proper position. Trim it by folding the flaps inside.



4

83. Turn the tail again. This step is more difficult than the last.

7



4

84. This step shows a hidden view. Hide the remaining white area by folding the flap down. Repeat behind.

7



4

85. The tail is now complete. Fold the flap at the front of the wing in half.

7



4

86. Fold the flap in half again.

7



4

87. Repeat steps 85-86 in the other wing.

7



4

88. Now you will lock the back closed. This is a simplified view of the top of the wings if they are allowed to open slightly. Take the flap that forms the angle ABC and fold it in half, towards the AC line. Be sure that the fold goes deep inside the model. Then, with tweezers, fold it again, from AC to deep inside the model, causing the model to pull tightly closed.

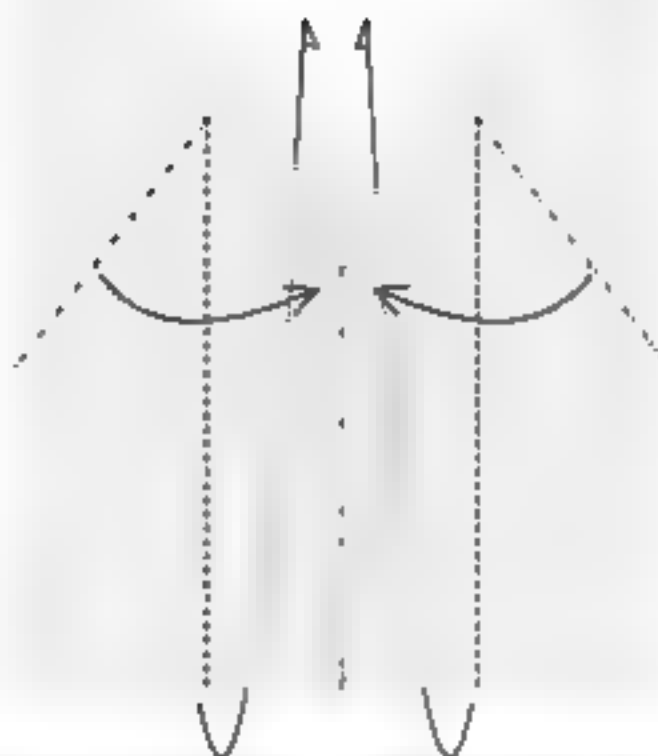
7

4

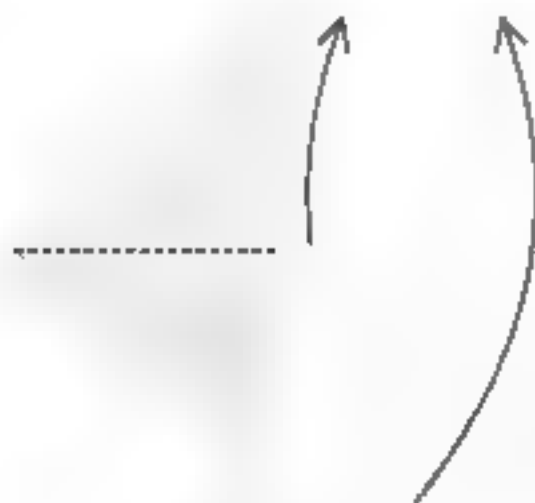
89. There is one more lock on the inside of the tail. fold it forward with tweezers. This fold completes the wings.



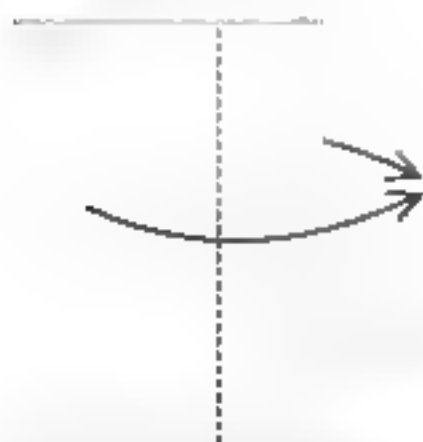
90. Insert your fingers inside the model, under just one flap of paper, and lift it up in the back, allowing the rest of the model to open slightly.



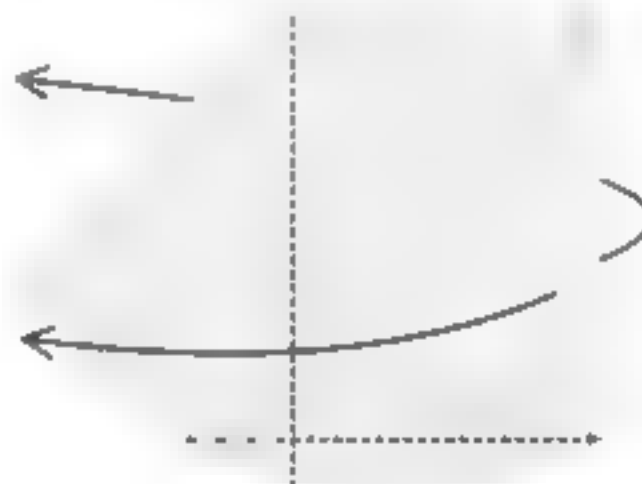
91. Fold the model back up as shown, swinging the head of the model all the way back towards the top of the tail. This is similar to executing two simultaneous squash folds.



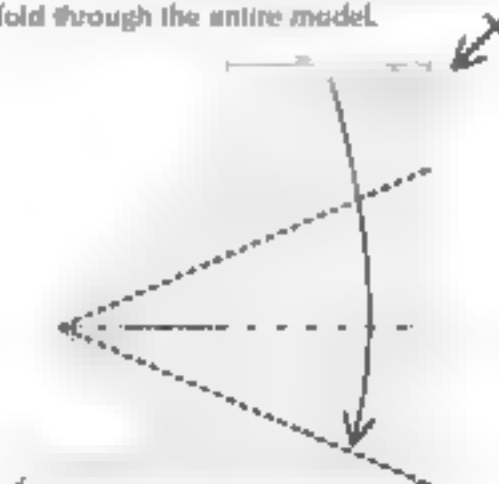
92. Fold a large flap upward. Repeat behind.



94. Fold the flaps back, at the base of the legs, which are hidden underneath.



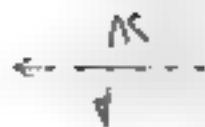
93. Carefully execute an outside reverse fold through the entire model.



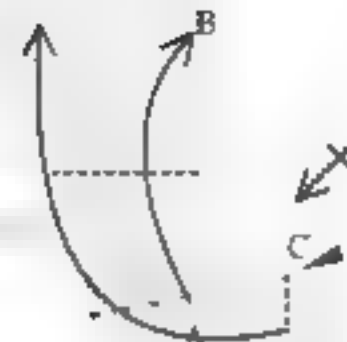
95. Fold the entire flap down, incorporating the inner reverse fold, through three layers. Repeat behind.



96. Fold the head down so that it is flat, and pull out a lot of loose paper; some will come from the rear portion of the neck, leg structure. The orientation of the wings, neck, and flaps underneath will all stay in place. You will need to incorporate two small folds to get the model to be flat again.



97. Repeat step 96 on the other side.



98. Pull the flap at A up to B. As you do this, the lower flap will pop upward. Reverse the line where indicated, and the whole construction will turn into a simple rectangle. Repeat behind.



99. Fold the flap downward. The strange angle of the vector will become apparent as you fold.



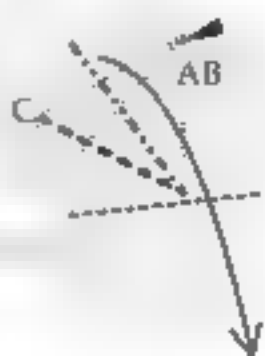
100. Crease the angle bisectors.



101. Crease the angle bisectors again, mountain folding this time.



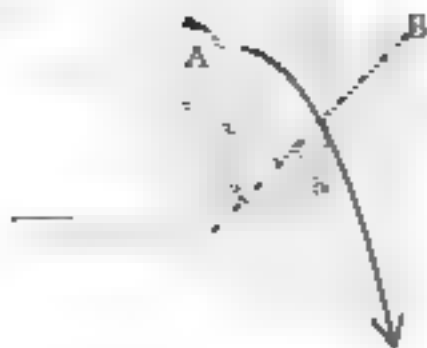
102. Fold the flap back up, incorporating the creases, bringing A to B, and swinging the entire triangle ABC inside the wing as you fold.



103. This is very difficult to describe and very easy to do. The dotted lines represent hidden structures, the bolded lines are folds on hidden flaps that are not shown. Fold the large rectangular flap back down, just as before, but as you do this squash fold under the top flap where indicated, incorporating the bolded creases. The idea is to bring the flap back down, but leave the wedge which has been incorporated into the wing in place. Look ahead to the next illustration to see the final product.



104. Fold the flap back up, incorporating the extra creases.



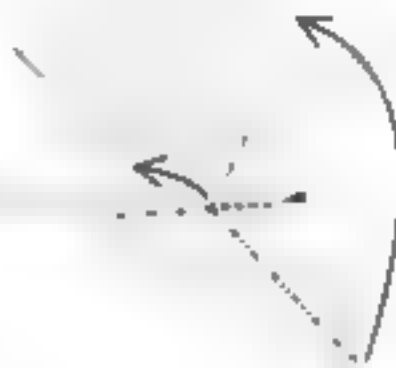
105. Finally squash fold the flap downward and press the model flat.



106. Repeat steps 99-105 on the other side. B



107. Fold the flap in. The angle is halfway between the edge and the dashed line.



108. Bring the flap back up to where it was in step 105, simultaneously tucking the angular area inside.



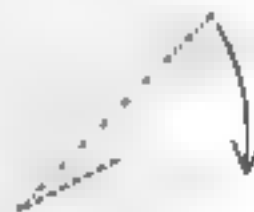
109. Reverse fold the large flap. The dotted line shows a hidden mountain fold.



110. Fold the flap to the left, but do not crease. The model will not lie flat.



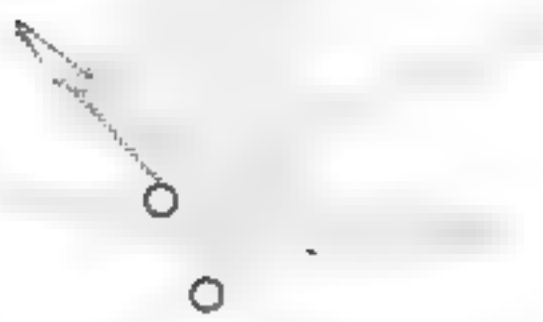
111. To do this simple construction, first precrease, then tuck the rightmost triangle underneath where indicated. This will cause the large flap to move back to the right. The other folds should follow naturally as you put the flap into place.



112. Fold the leg downward.



113. Repeat steps 107-112 on the other side. This is where the sculpting steps start. Some steps are somewhat vague, and open to interpretation. Use your eye to judge the proportions that you want to create, or gauge the proportions from the illustrations. There are few exact landmarks.



114. Pinch the outer two triangles with one hand and firmly grasp the neck where indicated. Lengthen the neck by slowly pulling it outward and upward and nest it firmly between the shoulder blades. Pull it up as far as it will go. The back, indicated by the arrow, will pull inward as you do this. Keep the outer layers flat. See the next illustration for the desired result.



115. Do a similar sculpting fold to lengthen the back legs and start sculpting the body. Grasp a leg where indicated and pull it backward, lengthening it as much as possible, and bringing it closer to the body, near the tail. The desired position is indicated by the dotted outline. As you do this the lower triangle will pull upward and open. Mold it down, and create a nice curve to form the torso. Repeat behind.



116. Finish sculpting the body by tucking the front and back flaps inside and lock the model closed in the rear by twisting the paper together. Mold the body by compressing the paper into a tight, rounded shape. Remember, in these steps it is very important to use your artistic sense to guide you.



117. The two front legs are inside the head/neck area. They can be identified because they have the same blunted end and creasing pattern as the back legs. Pull the closest leg down, squash folding it open at the highest point inside the model. There is only one way to do this.



118. Fold the leg in half. Repeat steps 117-118 on the other side.



119. Like this

120. This is a simplified view of the top of the model showing the proper proportions of the head, neck, shoulders, wings, legs and tail.



*Note: The following steps show a close-up view of the legs as you create the toes and claws. There is a lot of play in the length and structure of the toes. Play with them a bit and sculpt them as you like. The front toes should be more elongated than the back toes, but not longer, they are actually 1/2 as long.*

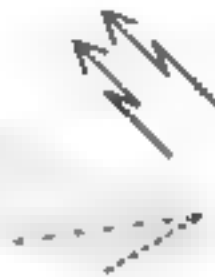
121 Reassemble the creases made in step 63



122 Fold and unfold



123 Crimp fold on the creases



124 Crimp fold again, pulling the toes into position



125 Complete each leg with two crimp folds

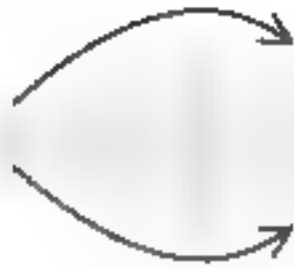


126 Like this. Repeat steps 121-125 on the other three legs



127 In the head there are five points. Fold the longest two of them downward and deep inside the model. These points are shown by the dotted lines. There should be one smooth line along both sides of the neck from the tip down to the body. The neck will become thick and not want to flatten completely

128 The dotted lines show the correct position of the points.



129. This is a close-up view of the head. Reverse fold the two flaps backward.



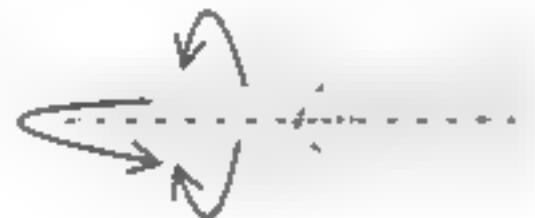
130. Reverse fold the two flaps again.



131. Thin the horns with a reverse fold on the top and bottom of both points.



132. Reverse fold the horns again.



133. Shape the head and neck by incorporating the indicated creases. See the next step for the final position.



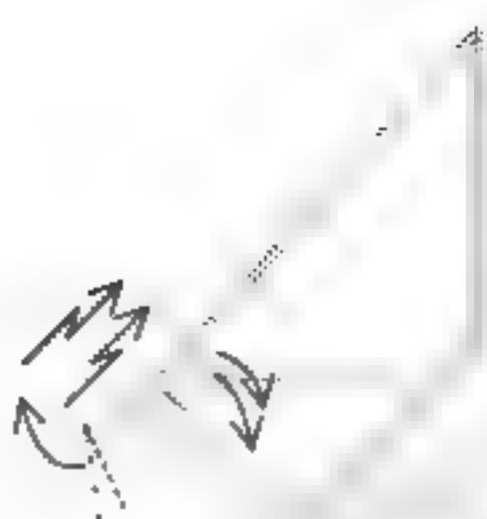
134. This view shows the correct shape of the head. Pull out one of the the long flaps that you tucked inside the body in step 127.



135. Open the flap.



136. Shorten the lower jaw with a crimp fold. Then fold it in half incorporating a reverse fold and tucking it into place inside the neck.



137. Complete the head with a small crimp fold on the upper jaw and by curving the horns downward and the lower jaw upward.



138. Like this



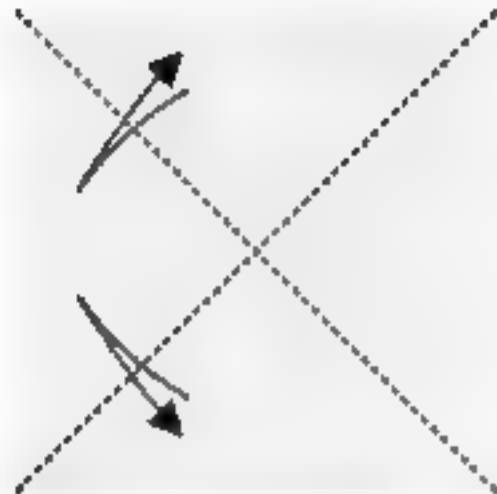
139. Thin the legs with mountain folds from the top of the legs to the top of the legs. Repeat behind



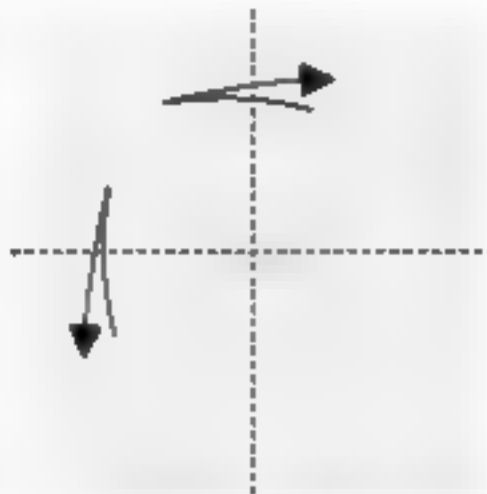
140. Complete the model by giving the tail some gentle curves and by curving the wings downward. At this point you should also mold the body into final shape assuming that the body is light and compact, and that the shoulderblades have not popped upward and out of position.

## Clown Fish & Sea Anemone

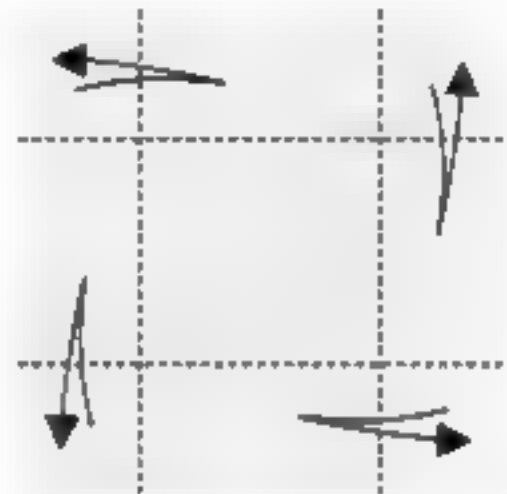
The idea for this model came to me when I was at a pet store and I saw a tank of clown fish. I noticed that the stripes on the fish were the same color as the tentacles of the sea anemone that I lived in, so I decided to fold the entire scene. The model is extremely difficult. If you have not folded it before, I strongly recommend learning to fold steps 69-132 on a single 10" square of paper before attempting the entire piece. It must be folded from extremely thin, foil-backed paper such as tissue foil or Japanese foil. For initial attempts use a square of at least 36". This will produce a model 6" across with a 2 1/2" fish.



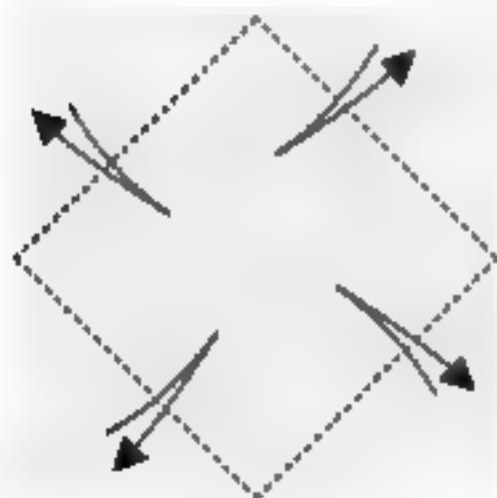
1. Fold and unfold.



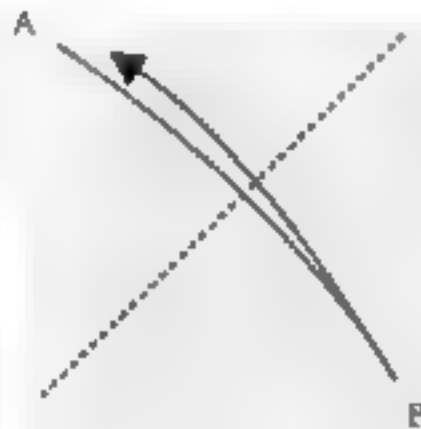
2. Fold and unfold.



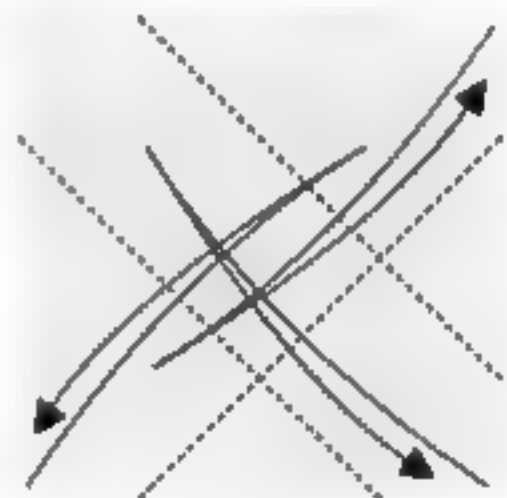
3. Fold and unfold.



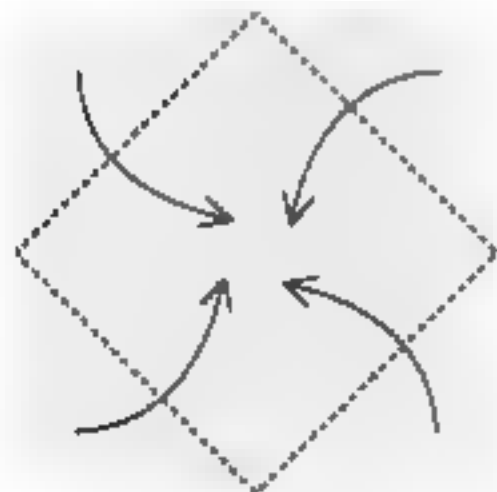
4. Blintz fold and unfold.



5. Fold, bringing A to B, and unfold.



6. Fold and unfold the remaining three corners.



7. Blintz Fold.



8. Turn the model over.



9. Rotate the model 45 degrees.



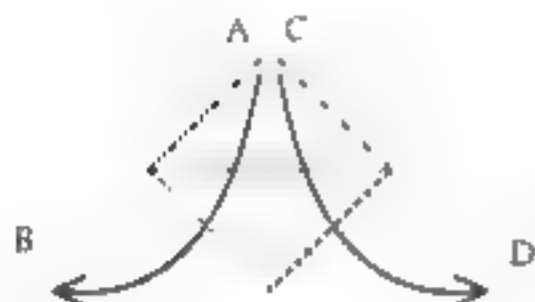
9. Fold the edge downward, allowing the lower flap to swing out from behind without being creased.



11. Repeat step 10 on the bottom.



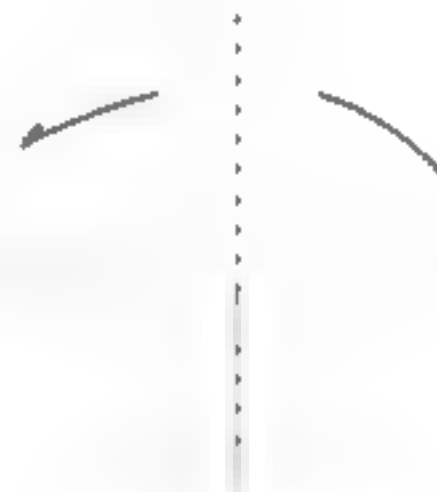
12. Rotate the model 90 degrees.



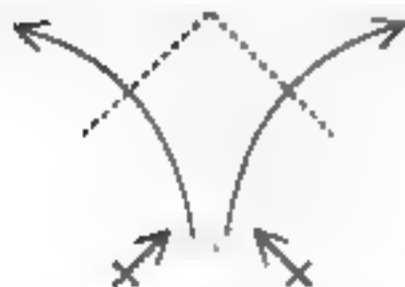
13. Fold downward bringing A to B and C to D, allowing a flap to swing outward, as in step 10. The dotted line shows a hidden valley fold.



14. Repeat the fold on the bottom.



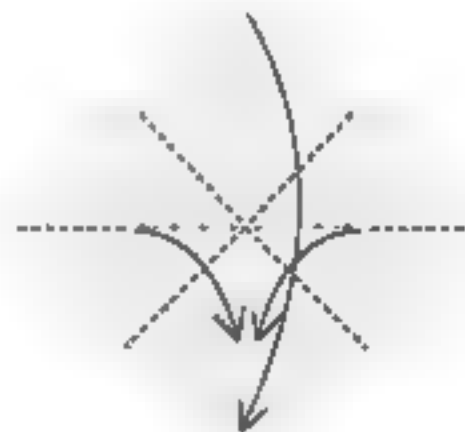
15. Fold the model in half.



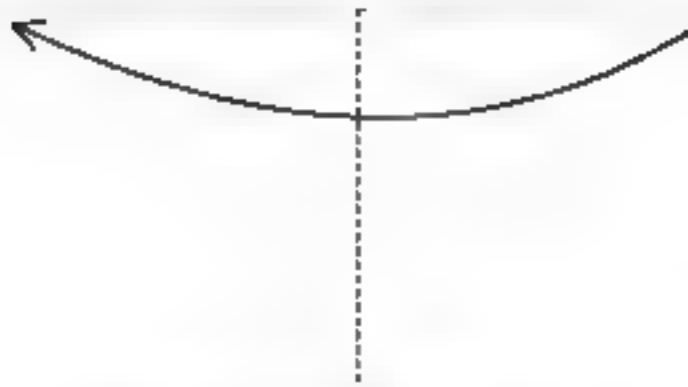
16. Fold the flaps up, repeat behind.



17. Fold two of the four layers upward.



18. Fold the model back in half, bringing the sides of the center square toward each other as when completing a sink using the spread squash method.



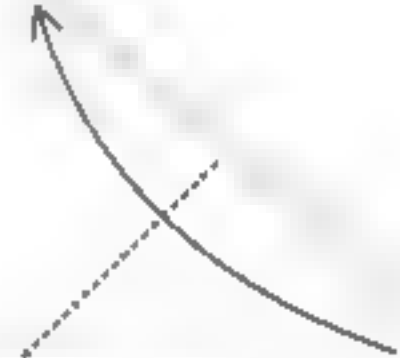
19 Carefully fold the model in half.



20 Reverse fold the large inside flap right through the center of the model, so there are seven flaps on the left.



21 There are now seven flaps on the left side of the model. Inside the model, on the right side, there are four smaller flaps, one wrapped around the other three. The location and shape of these flaps is indicated by the dotted line. Turn the model over so that the seven flapped side is on the right.



22 Carefully fold one flap upward.



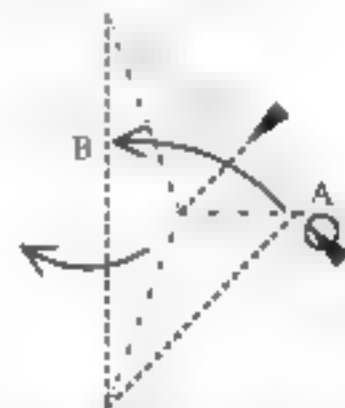
23 Fold a rabbit ear very accurately through all layers.



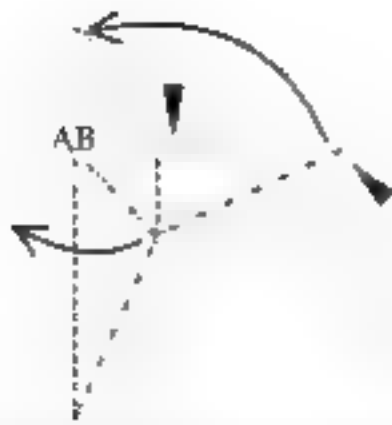
24 Fold the tip down and back up.



25 Untold the flap completely. NOTE: The following folding sequence will be difficult because there are so many layers. One half of each side will be easier than the other because on one side the creases are in the right direction, on the other you will be reversing the creases.



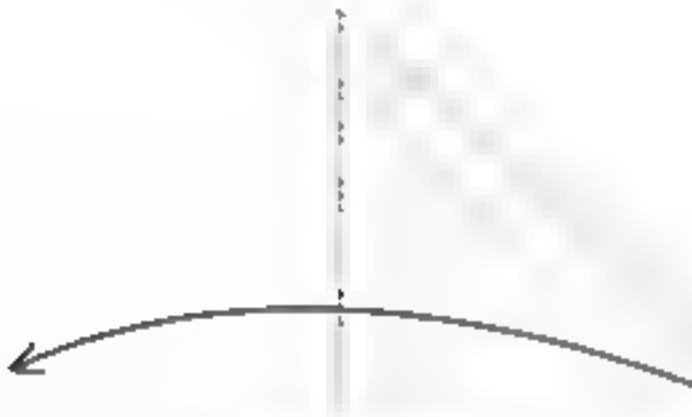
26 Start to fold a quadruple rabbit ear by grasping the flap where indicated, and squash folding the top half of the flap bringing A to B. At the same time bring the two side flaps at the top inward. This procedure will result in a double rabbit ear which is a half of a bird base structure which is symmetric about the y axis.



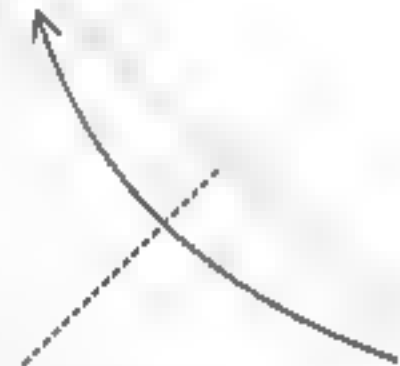
27. Complete the quadruple rabbit ear by folding a double rabbit ear on the other half of the flap.



28. Completed quadruple rabbit ear. Unfold the flap completely.



29. Fold the flap to the left.



30. Carefully fold another flap upward.



31. Fold a rabbit ear very accurately through all layers of the flap.



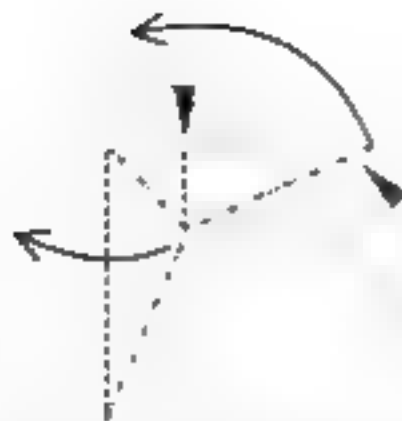
32. Fold and unfold.



33. Untold the flap completely.



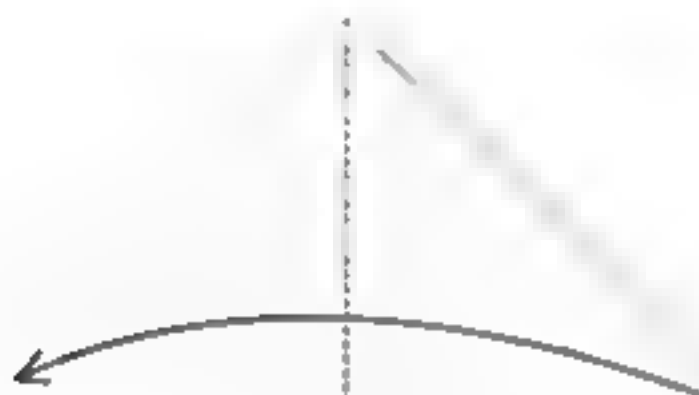
34. Execute a double rabbit ear as done previously but this time the two sides will be connected. Remember that all the creases are already in place. This maneuver will be easier than the one done in step 26.



35. Execute the double rabbit ear on the other half of the flap.



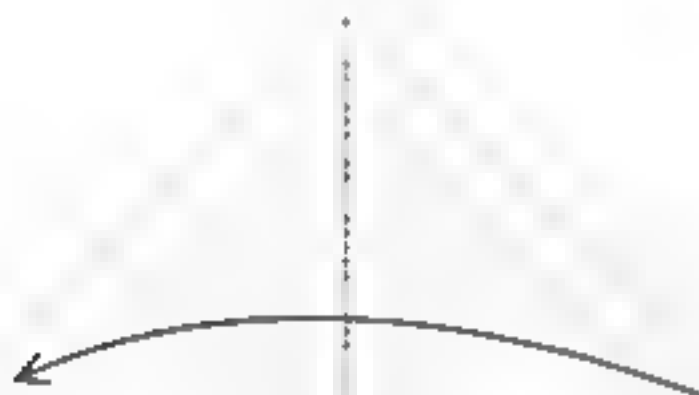
36. Unfold the flap completely



37. Fold the flap to the left.



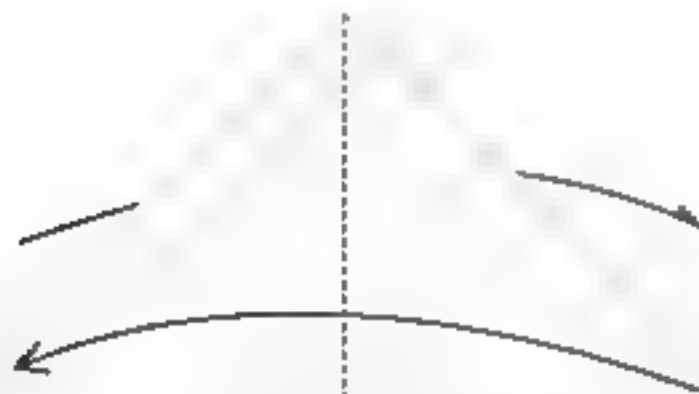
38. Repeat steps 22-28 on the right flap



39. Fold the flap to the left.



40. Repeat steps 30-36 on the right flap



41. Fold the flap to the left, and another behind to the right.



42. Repeat the creasing sequence and step 41 on the remaining three flaps, but not on the final flap





43. Rearrange the flaps so that they are as they were in step 22, with the one flap containing the four smaller flaps on the left, and the seven other precreased flaps on the right.



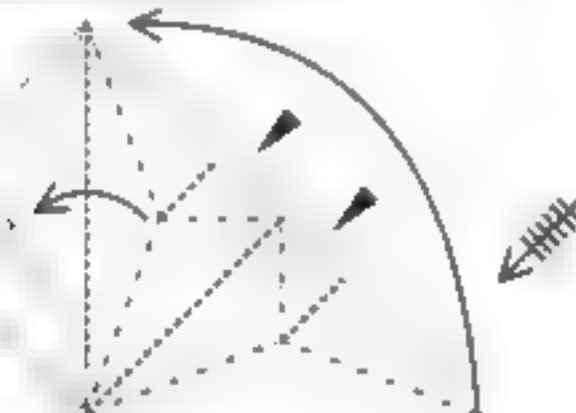
44. Do the same rabbit ear crease through all four of the hidden flaps on the left. The dotted lines show the hidden structures. Be as accurate as possible; this is very difficult as there are many layers.



45. Fold the hidden flap down and up.



46. ...and unfold.



47. The internal precreasing is now completed. Reassemble each of the seven flaps into its respective birdbase form, exactly as precreased in the previous steps.

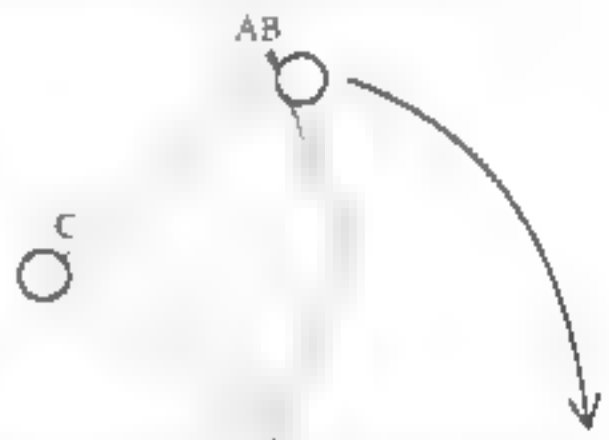
48. The model is now a tightly compressed ball of flaps with many layers that must be disencumbered. Internally the top of the model is similar to a waterbomb base in that there are four ridges that each come to a point in the center. But each of these ridges has many layers of paper wrapped around it. Each ridge is also collapsed upon itself and tucked inside the model. This accounts for the four flaps of paper inside the flap on the left side. These internal ridges must now be liberated. The process is surprising, and not difficult, but unnerving the first time you do it.



49. Fold all the flaps in the central ball to the right,



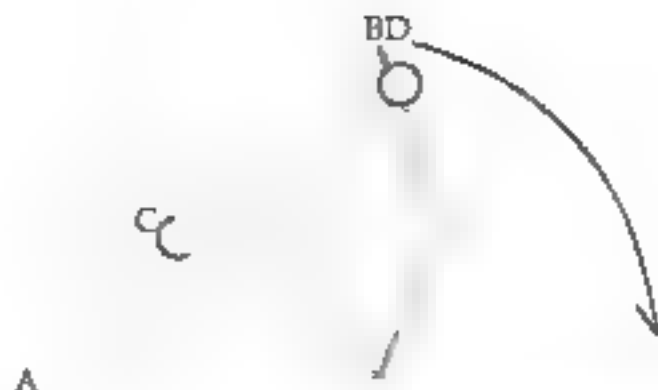
50. Fold a single flap in the front and behind to the left.



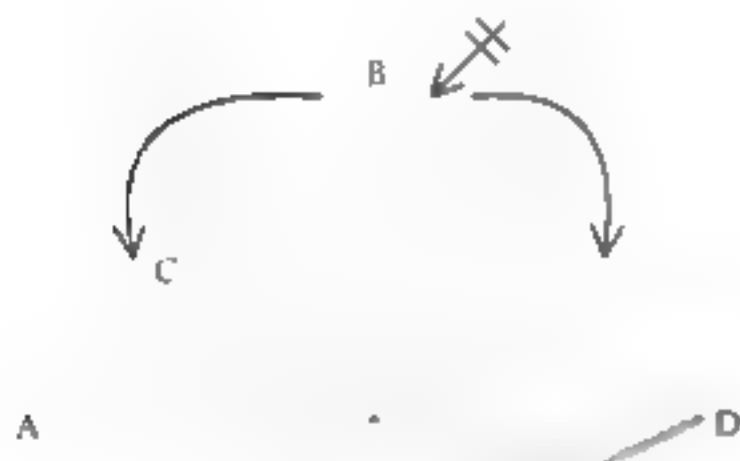
51. Grasp the model between your thumb and forefinger at the two points indicated, and gently but firmly pull the two points A and B away from each other. A and B will separate and B will rotate downward and to the right. Keep pulling until the ridge that appears between A and B is opened completely. Point C indicates the location of the flaps inside the model. The model will become 3D.



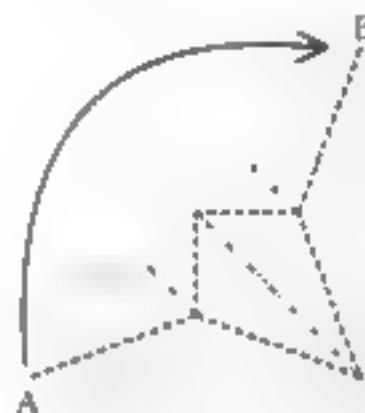
52. The model is now 3D and will remain so for the rest of the folding sequence. Rotate the model 90 degrees counterclockwise



53. There are three more ridges inside like the one you just liberated, but they are more difficult to find. Pinch exactly eight flaps where indicated at BD and one flap at point C and gently pull points B and D apart as in step 51



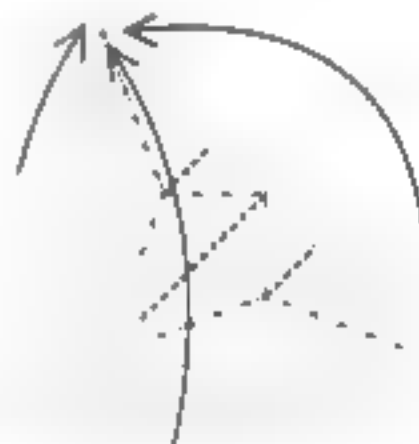
54. The model is getting bigger by the minute. Complete the expansion process by liberating the remaining two ridges, exactly as with the previous ones.



55. At this point the model is very large and symmetric in four directions. The back part that is hidden in the illustration looks exactly like the front. Now, reassert the creases that were formed previously on the ridges in steps 44-46. To do this swing point A up to point B incorporating the indicated creases through all layers.



56. Now allow the model to flop back into position.



57. Repeat steps 55-56 on each of the other 3 ridges.



58. The entire model is composed of double thickness layers. Pop out one thickness, reversing the direction of the creases, of one section of the ridge where indicated.



60. Repeat steps 58-59 on the back and sides.



59. Repeat the process with the next pocket.



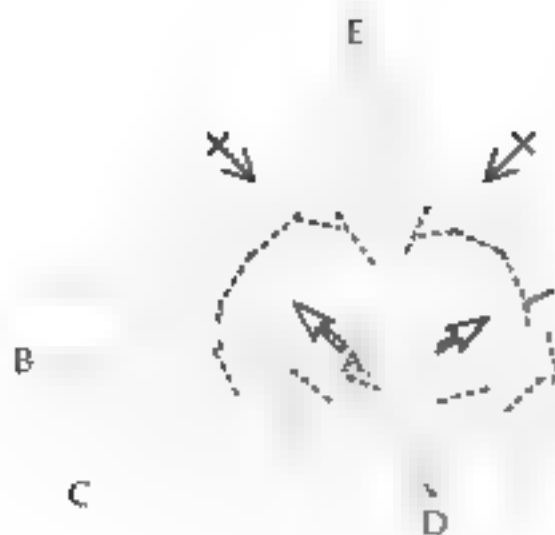
61. Now, do the process on the first two pockets of the horizontal plane



62. ...and the next two.

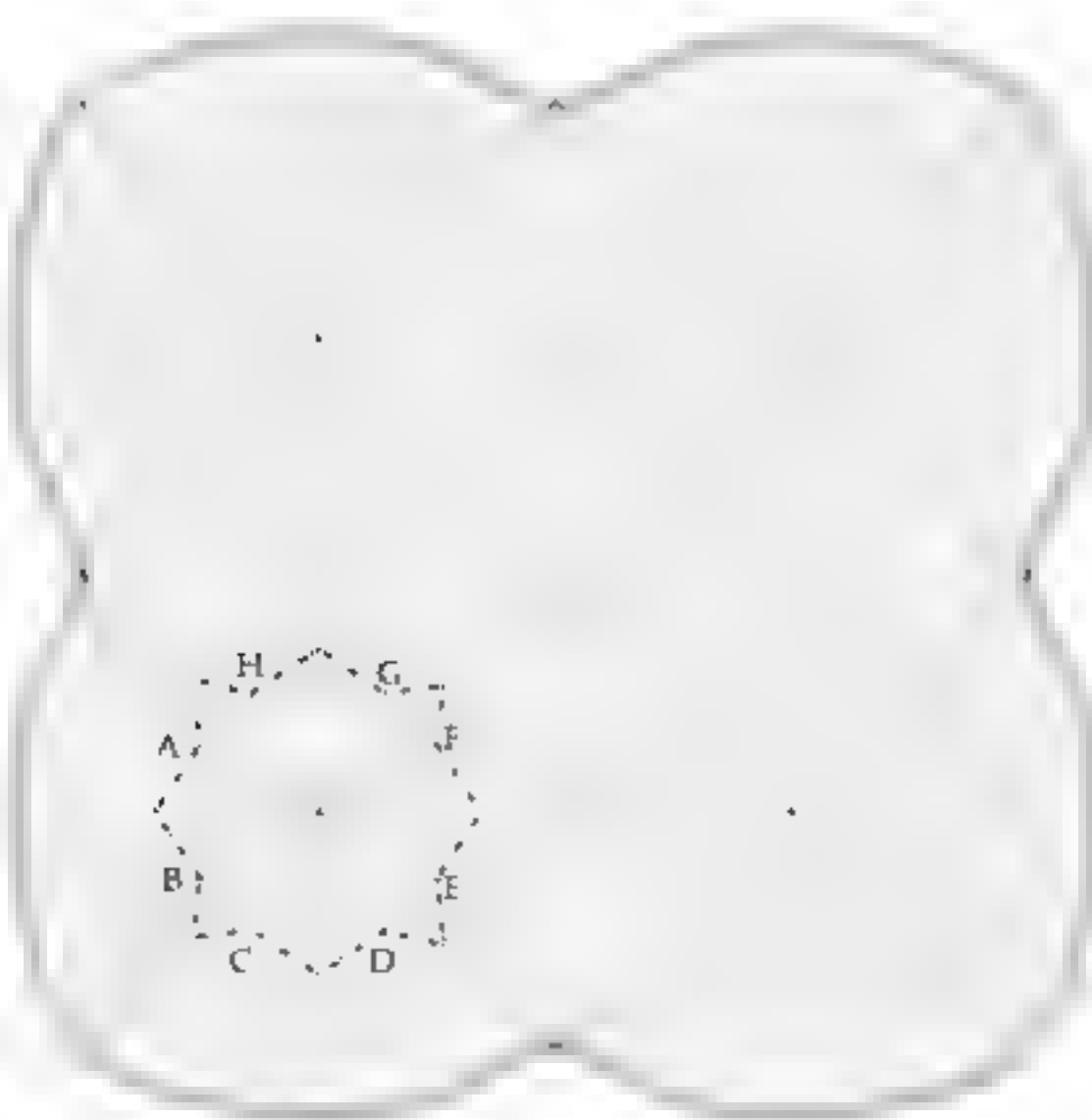


63. Repeat steps 61-63 on the three remaining areas of the model, one in front and two behind.



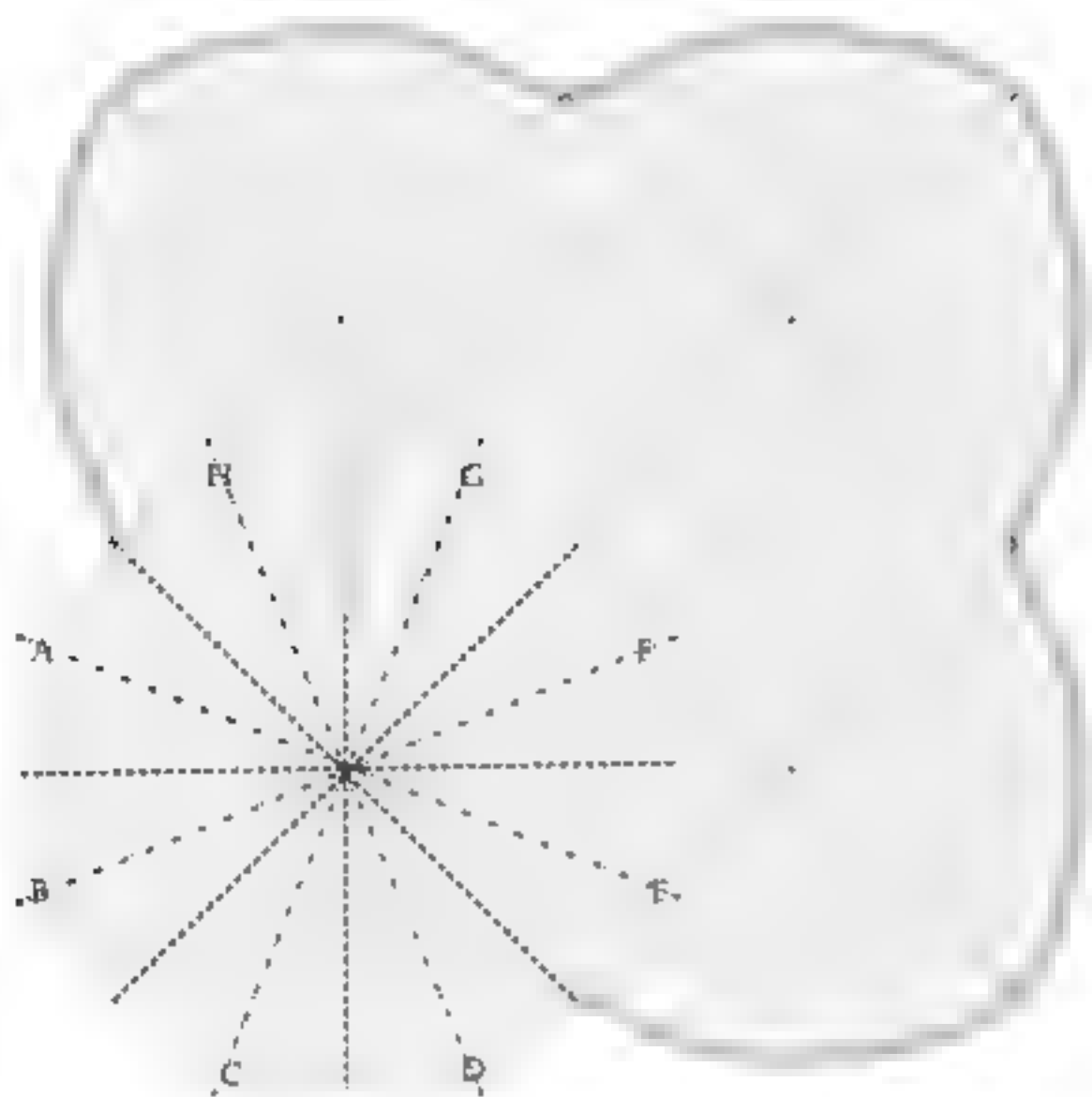
64. There are four final areas that need to be raised. Each of the four large pockets contains a deep, inverted, eight-sided point. These must be inverse-sunk and brought to the surface. As you do this the model will implode and points A, B, C, D & E will all meet at point E. The same thing will happen on all four sides, and the look of the model will go from very large to much more compact. Look ahead to step 65 to see where you will end up.

These very confusingunks are more easily executed from the bottom of the model. Detailed instructions follow but if they are more confusing than helpful, remember that all you are doing is an eight sided sink of an octagonal area, so that the point deep inside the model becomes turned inside out to meet the other points



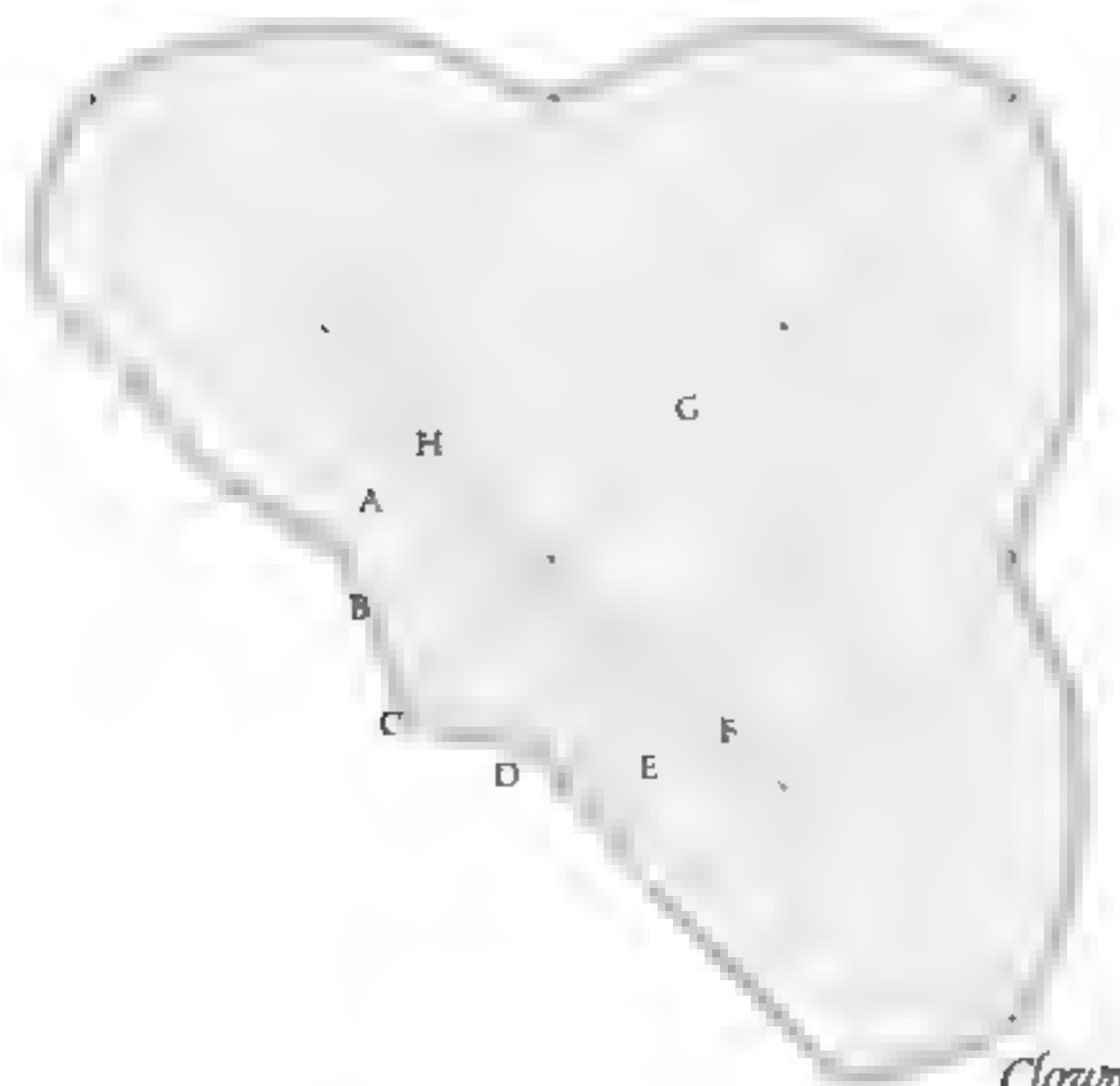
64a. This is a simplified view showing an orthogonal projection (a 2D drawing of a 3D object) of the bottom of the model. To see this view one must turn the model over and stretch the bottom open slightly. The four regions represent the four eight sided spikes that need to be sunk, and the center represents the large spike in the center of the model. This view shows only one of the four spikes shown in the above illustration.

Start the sink by carefully molding an octagon on the indicated creases, opening the model as little as possible while doing so. First, create a mountain fold from A to B turning points A and B inside out. Then, crease a line from B to C turning C inside out, then C to D in the same manner. Continue around the circle until the entire octagon is complete. Note: there are only eight folds being done; each pair of lines, AB, BC, CD, etc., represent only one crease.



64b. Now complete the sink by folding the model back up on the creases while bringing the two layers, the one shown and the layer underneath, as close together as possible. As you do this, the model will become very compact around the area that you are working, and become smaller, as it was before you exploded it in steps 51-57. Be gentle and patient. Remember that the model will be symmetric in four directions and that it will be exploding as you do these folds so pockets will be forming and everything will be tucking inside itself very tightly. Keep in mind the internal structure of a bird base as you work. This will make the process simpler and help you not to get lost.

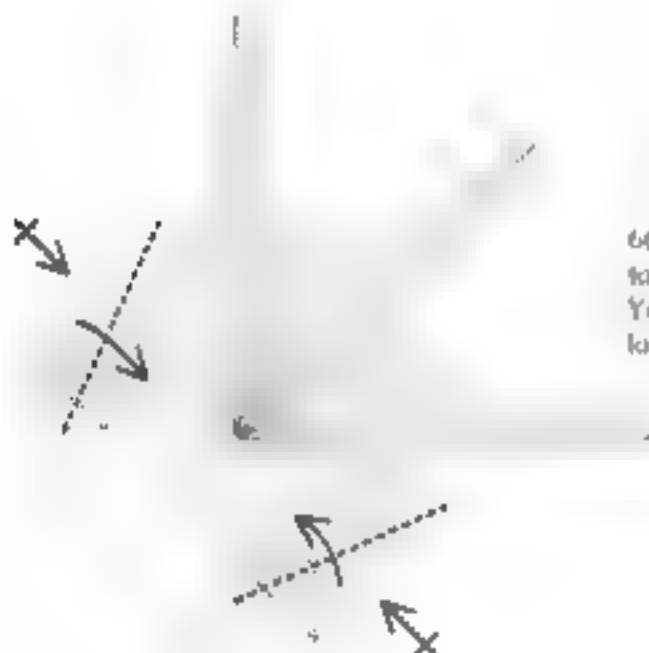
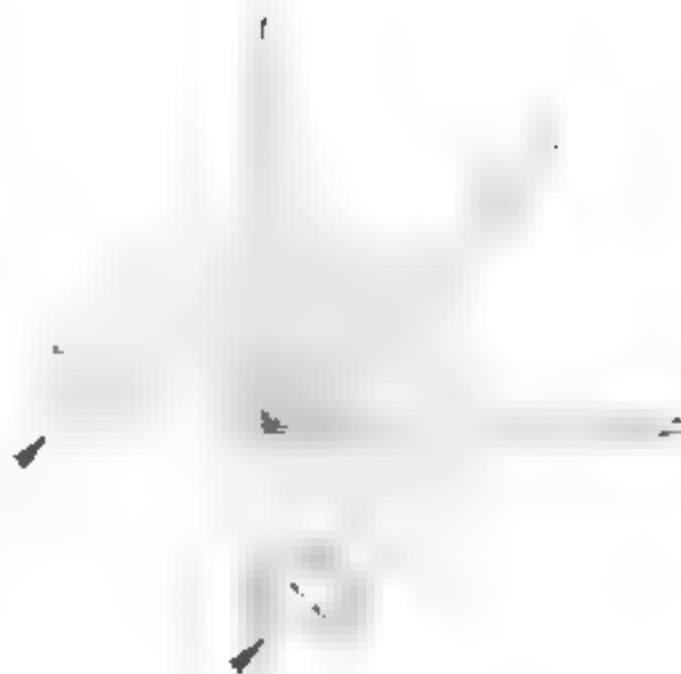
Folding the sink back up can be something of a puzzle. First, bring point A to point B and create the valley fold between them, starting from the edge and working toward the center of the pit. Repeat the process with CD, EF & GH. Next fold BC, DE, FG & AH. This order will make what is going on more intuitive.



64c. This figure shows the first sink completed. Notice how compact the model has become in comparison to step 64a. Repeat the sink on the other three areas. The entire process will become more difficult as you progress.

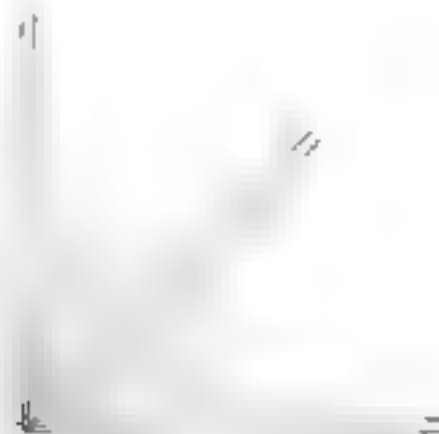


65. The four sinks are complete.  
Open the flap out from behind.



66. Reverse fold the two hidden flaps. They are very easy  
to find and are part of the top of the bird base structure.  
You are only folding them to make the next step easier. The  
lower portion shows an x-ray view of the hidden flaps.

67. Fold the two flaps upward  
as shown. Repeat behind in the  
opposite direction.



68. We have completed the square from  
which the clown fish will be made.

69 For most of the rest of the model only the fish portion of the paper will be shown. Occasionally landmarks will be shown while you know how things are progressing. As you fold this very difficult sequence, it is very important to treat the multi-flapped, white area as if it were one square of single thickness paper. Be especially careful that the corners stay in the form of right angles. If you stray, you will likely become completely lost.



70 To start the fish, the square must be marked at  $1/32$ . Fold and unfold in half.



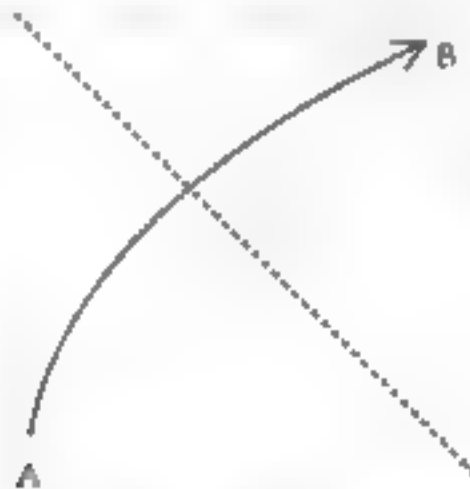
71 Fold again, creasing only the edge to mark  $1/4$ ,  $1/8$ ,  $1/16$  &  $1/32$ .



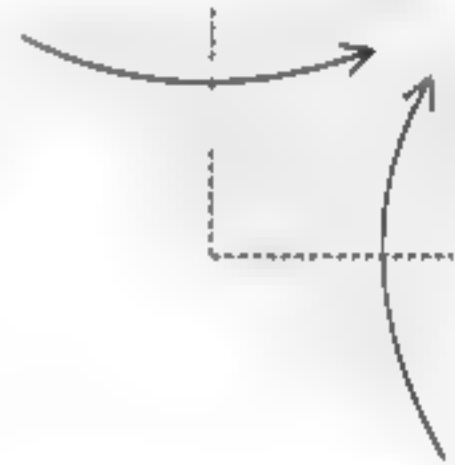
72 Carefully fold the model in half diagonally.



73 Very accurately mark the  $1/32$ nd crease through both layers, and unfold to the previous step. This is an extremely important landmark.



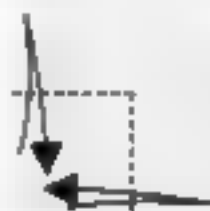
74 Carefully fold the model in half diagonally at the  $1/32$ nd mark. Corner A should lay exactly on the line AB.



75 Carefully fold the corners inward.



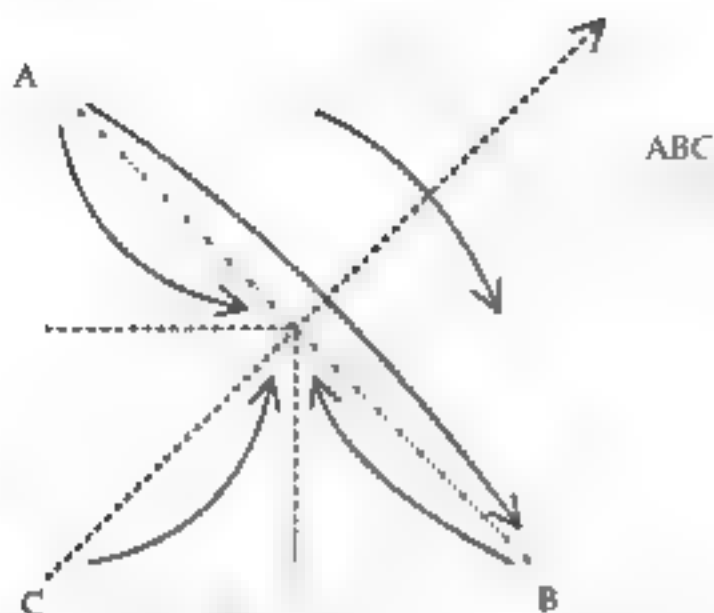
76 The white stripes should be exactly the same thickness and here should be a small colored square in the upper right-hand corner. Fold the flaps down.



77 Note that another perfect square is formed in the corner. Fold and unfold the flaps.



78. Unfold to step 74.

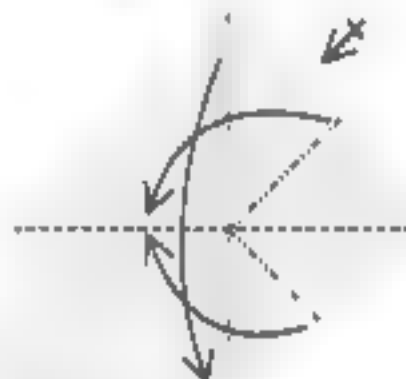


79. Fold the model back up on the creases as indicated by first bringing A and B towards the center, then bringing C to meet A and B, while incorporating the extra creases. Note that the paper will bend downward as you do this, and that points A, B, and C will not meet the center of the paper; they meet at one corner, as shown in step 80.

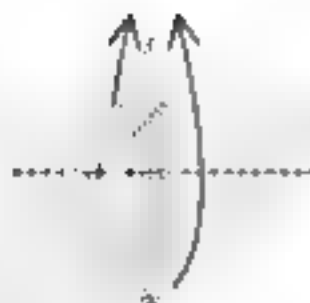
80. Rotate the model 135 degrees.



81. Fold the two flaps upward.



82. Fold the flap back down, incorporating the extra creases created in the previous steps. Repeat behind.



83. The shorter, almost triangular area shows a hidden flap underneath the top layer of paper. Fold the top flap upward, which will cause the hidden flap to fold to the right, as when executing a petal fold, such that the bottom corner of the new-colored region, shown by the taller triangle, starts at the lowest point of the smaller area and goes straight upward, parallel to the white edge. There is no landmark for this fold until you have done it, but once you have done it, it will be clear what you were meant to do. Examine the figures carefully.

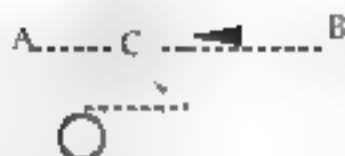




84. Fold the flap down and back up.



85. Fold the flap down, matching the previous crease with the horizontal edge. Crease very sharply and unfold.



86. This fold is unusual, but not difficult. Anchor the model with one finger and push in the vertical ridge where indicated. The flap up will pull down naturally. Guide it along AB and create a new colored, horizontal ridge.



87. This is a 3D intermediate view of the step. Completely unfold by bringing the popped up flap down to the position it was in when it was created in step 84.



88. Fold the center flap upward.

89. Fold the flap back down.



90. Fold and unfold the flap.

91. Swivel fold on the crease. The top of the vertical valley fold is slightly to the left of the bottom.



92. Fold the flap to the right



93. Petal fold upward. This fold can be very tricky and depending on how accurately you've folded, must be played with for it to lie correctly. The lower point should come up as far as possible without exposing any white to the right of the stripe.



94. Sink the triangular area.



95. Fold the flap back to the right. This is similar to a wrap



96. Now tuck the white flap inside the model underneath the white stripe. This is like a sink and is very difficult.



97. Tuck the tab at the top inside to lock the stripe in place.



98. Fold the fin upward.



99. Pull out some loose paper, so that the bottom of the fin is proportional with the top.

110. Repeat steps 84-99 on the other side.

101. Reverse fold the flap. Make the raw edge flush with the folded edge on the right. It does not line up with the raw edge of the colored flap above it. Repeat behind.

102. Closed sink the front corner. This is extremely difficult and will be easier if you roll the lip between your thumb and forefinger before sinking. You may have to clean up the sink from the other side when you are done. It is important that this fold be perfect.

103. Carefully crease only the large flap along AB and unfold. Do not crease the fish. Repeat behind.

104. This is very difficult! Sink the large, four sided figure right through the center of the model, without affecting any of the structures of the sink done in step 102. This will start to isolate the fish from the stem that it lies on.

105. Pull the fin upward. Repeat behind.



106. Pull out only one layer of loose paper. Repeat behind.



107. Swivel fold the flap to the left. Repeat behind.



108. Tuck the flap inside. Repeat behind.



109. Fold the flap back down. Repeat behind.



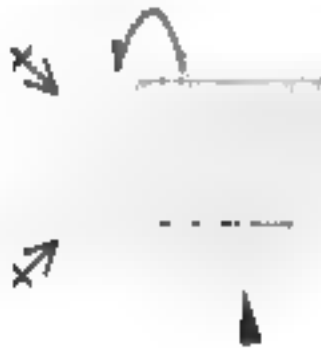
110. Sink the white area so that it is hidden inside the model.

1

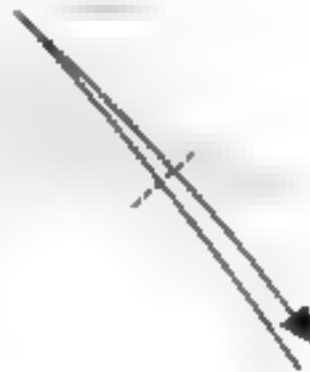
111. Like this



113. Fold a rabbit ear on the flap. Repeat behind.



114. Anchor the stripe by reverse folding the paper at the bottom inside the model, and folding tab at the top over the top edge. This is very difficult because of the thickness of the model. Repeat behind.



116. Fold and unfold the flap as shown



118. Note that the vertical stripe should be parallel to the others. Sink the two corners triangularly to make the rear stripe the same width as the first two.



113. Fold the flap up, carefully noting its orientation in the next step. You may have to twist and pull at the model or rearrange flaps so that the corners are in the right place. Repeat behind.



115. Reverse fold the large flap



117. Execute a double outside reverse fold, bringing the center point right through the middle and bring the outside flaps inside out.



119. Fold the flap down and opening the model but creasing the body as little as possible.



120. Fold the flap back up on the creases as indicated. This is like folding a small preliminary base with a large flap attached to it.



121. Pinch the model where indicated and slide the tail down so that the white lines are parallel. The top area will slide out and pop into place when you are done.



122. Slide the tail back up into its final position.



123. Do a color change on the inside part of the stripe, by sinking it and turning it inside out.



124. Now we will do some folds to shape the tail. Crimp fold the tail inside the model.



125. Fold the flaps inside.



126. Fold the flaps inside.



127. Complete the tail by moulding it into a rounded shape, and folding the two lower flaps inside.



128. Like this



129. Reverse fold the front corners inside



130. Fold four flaps inside

131. Fold four flaps inside. Note that there are two creases on each flap



132. Compress the sides of the white area and mold them into a 3D stem, so that no color shows

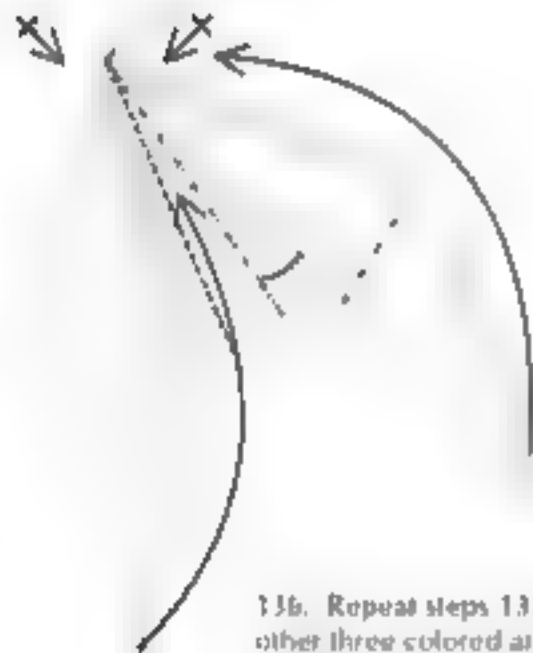
133. Now we will start the final locking folds that complete the model. Bring the white edges together while bringing the colored layers in, tucking them underneath the white edges. Lock as few layers on the inside of the model as possible



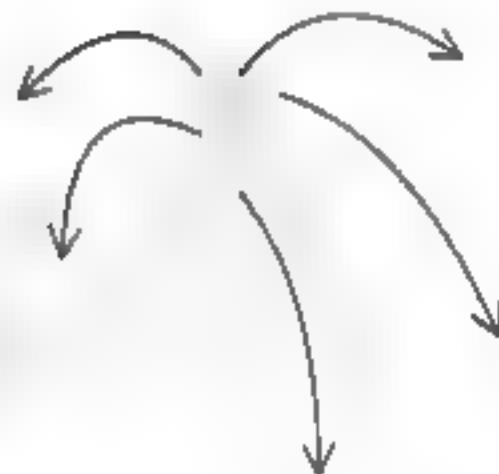
134. Fold two flaps to the left.



135. Fold the large flap up, locking the tucks in place.



136. Repeat steps 133-135 on the other three colored areas. The two not adjacent to the fish will require two thicknesses to be tucked inside not just one.



137. The model is almost complete. In the cone above, there are 22 separate spikes. Carefully open the model so that each spike can be seen.



138. Pinch and roll each of the points into a tight spike. Cramp told the fish back into the model so that its tail is inside the model and its head is peeking out the side.

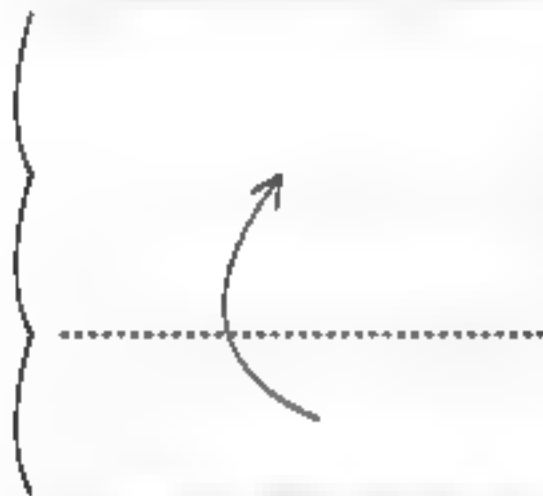
139. Completed model.



## Seven Simple Bracelets

The first of these was the "Zig Zag bracelet," which was created spontaneously by my friend, Sue Nickles, a beginner level folder who had never created anything before created the other bracelets mostly through experimentation. Because I wanted some simple models for this book. These models can be folded from any type of colored origami paper. A 10" sheet should produce a bracelet large enough for anyone's wrist. They can also be folded in miniature from 2" sheets to make rings.

### 1 - Horizontal Thirds



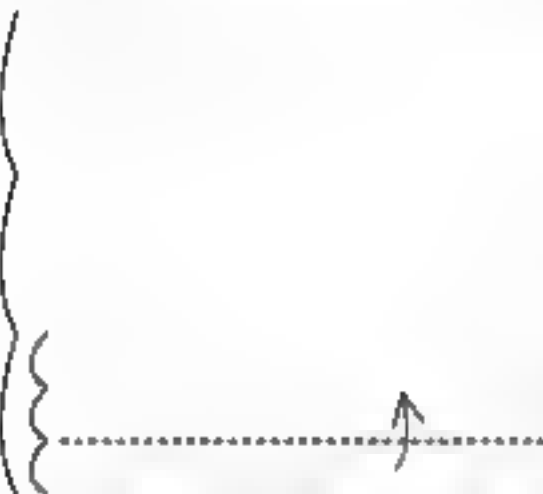
1 Valley fold one third of the paper upward.



2 Note that the white region will be exactly the same size as the colored region. Fold the top third down.



3 The edges should line up exactly. Unfold the model completely.



4 Fold the lower edge one third of the distance between the bottom and the crease made in step one.



5 Fold the edge up again. The folded edge should exactly meet the crease made in step one.



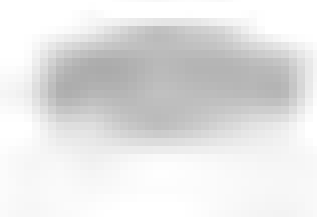
6 Fold the flap over the middle crease.



7 Repeat the folding sequence on the top edge.

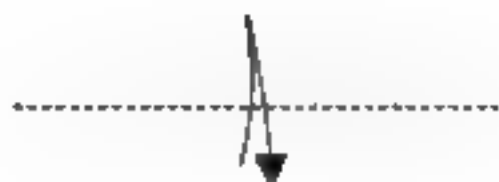


8 To complete the bracelet, bend the two ends backward and slip one end inside the other.



9 Completed bracelet.

## 2 - Diamonds



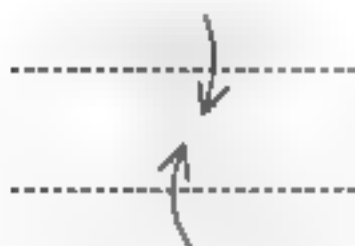
1. Start with a square of paper, white side up. Fold in half diagonally and unfold.



2. Note the location of the crease from the previous step. Fold and unfold along the other diagonal.



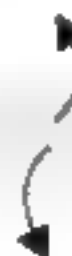
3. Fold the bottom and top corners into the center.



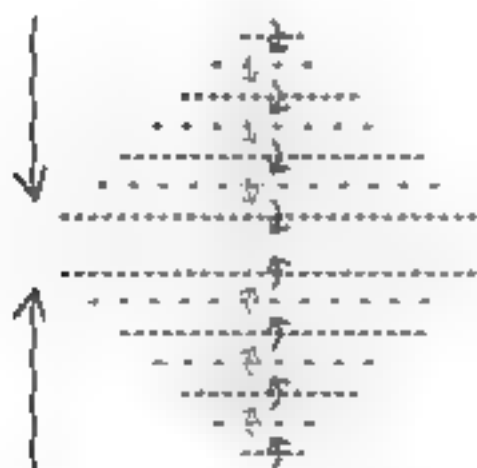
4. Fold the edges into the center.



5. Fold the edges in again.



6. Unfold the paper completely.



7. Fold up the top and bottom halves of the paper like a fan, valley folding, then mountain folding, one line at a time.

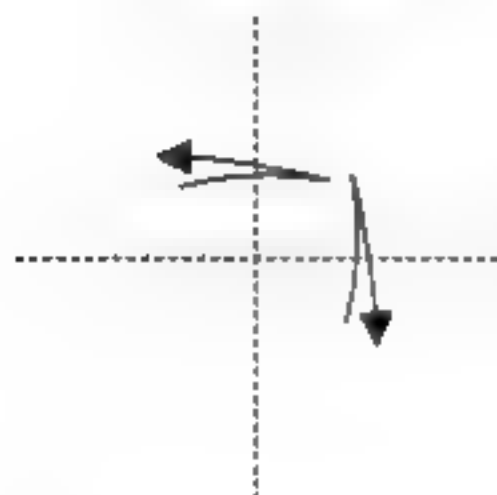


8. To complete the bracelet, bend the two ends backward and slip the right end inside the left, all the way to the indicated point.



9. Completed bracelet.

### 3 - Zig Zag



1. Start with a square of paper white side up. Fold in half along the diagonals as with the previous bracelet.



2. Pleat up as with the previous bracelet, but pleat in fourths, not eighths. Pleat only the top half of the paper.



3. Fold the flap up at a distance of two-thirds the total height of the model.



4. Fold the flap back down, along the horizontal crease made across the center.



5. Now, fold upward using the bottom edge of the model as a guide.



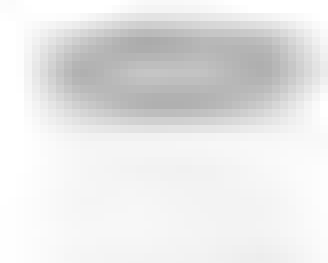
6. Finally fold the top down to the bottom edge.



7. Pull the colored flap out in front of the white flap.

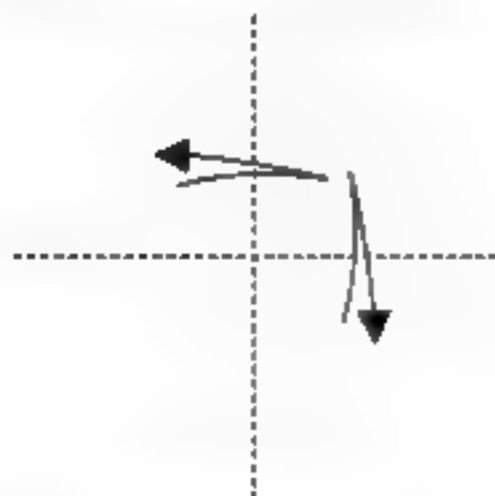


8. To complete the bracelet, bend the two ends backwards and slip the right end inside the left, all the way to the indicated point.



9. Completed bracelet.

## The Multi-Bracelet



1. Start with a square of paper white side up. Fold in half along the diagonals as with the previous bracelet.



2. Fold the top corner down, but not all the way to the center. The actual distance does not matter. (Different distances will affect the size of the colored regions on the model.)



3. Fold the other three flaps the same distance away from the center.



4. Flip the top and the bottom by pinning and folding in half.



5. Model is now folded in half again, allowing the center flaps to swing out. Turn the model over.

## 4-Amulet



6. Bracelet number four. To complete step number four, fold the other as before. To go on the next bracelet, fold the colored square in thirds.

## 5-Two Diamonds



7. Bracelet number five. To go on to the next bracelet, fold the two small flaps outward.

## 6-Three Diamonds

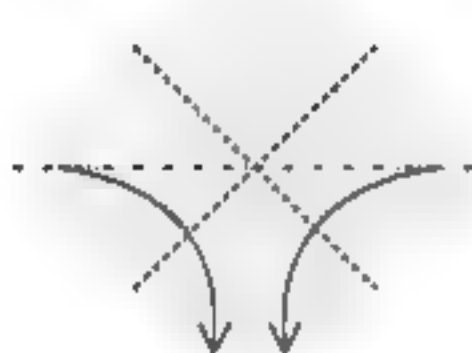


8. Bracelet number six. To go on to the next bracelet, tuck the upper and lower flaps, which contain the first and third diamonds, under the large flaps that extend the length of the model.

## 7-One Diamond

9. Bracelet number seven.

**Diving Duck** - This model was inspired by my friend Sue Nickles. One day while walking around the lake near my house we saw some ducks diving under the surface of the water to feed, leaving only the feet and rear ends sticking up above the water. Sue suggested I should fold just that, so I did. Though the model is pretty simple in structure, it has some procedures that are very unfamiliar including some strange sinks, a color change, and some 3D folding which rate it a level III. The model can be folded from any type of paper. A 10" piece of paper produces a model 5" high.



1. Start by folding a preliminary base with the colored side in.



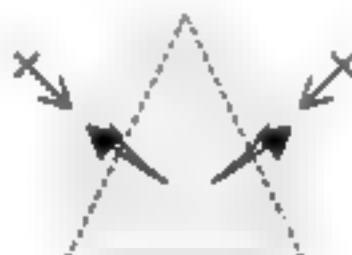
2. Fold the front flap all the way up. Repeat behind.



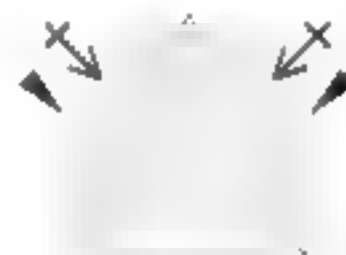
3. Fold the corners into the center and unfold. Repeat behind.



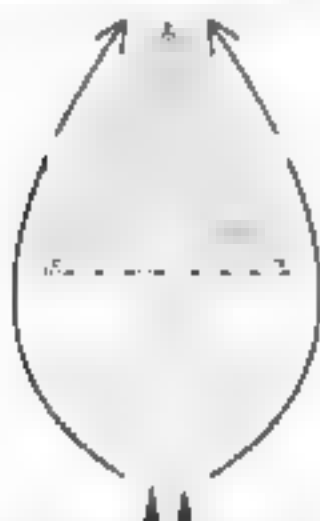
4. Reverse fold on the creases. Repeat behind.



5. Fold and unfold creasing very sharp. Note that the crease goes from the center to the outside corners; the flaps will not come all the way to the center. Repeat behind.



6. Sink the white diamond-shaped area under the colored flap. The dotted lines show the path of the sink under the paper. The sink will be quite different if the crease made in the previous step is not sharp enough. Repeat behind.



7. The dotted lines now show the outline of the internal structure. Reverse fold the two side flaps up to the top.



8. Fold one multi-layered flap to the left.



9. Fold and unfold the two flaps.



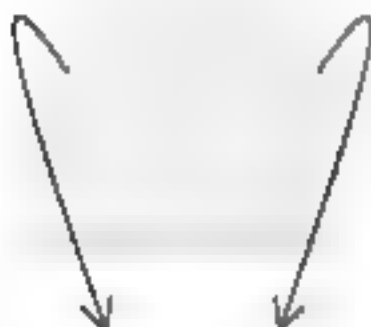
10. Reverse fold on the creases.



11. Fold two flaps back to the right.



12. Repeat the last five steps on the left side.



13. Execute a color change by opening up the model, pulling the large colored flap all the way down and reassembling on the previously existing creases.

B



14. Fold one layer to the left.



15. Tuck the white flap inside. Repeat behind.

AB



16. Pinch the two white flaps where shown and lift slightly, then take the entire bottom flap and reverse fold it all the way up inside the model. If you fold correctly, the flap should tuck inside the model very cleanly.

17. The rest of the steps are sculpting steps. At this point the model will be thick enough that it will not want to lay flat. Allow the white flap to pop open and notice that the model takes on the shape of a three sided pyramid with an equilateral triangle at the bottom. Set the model on the triangle. The totally colored side of the pyramid is the front, and the opposite side is the back.



18. From the front of the model pinch the colored flap and roll a valley fold into the paper where indicated. The entire front of the model will become a curved surface.



19. Continue rounding the front by making a mountain fold from the base of the foot to a point approximately one third along the front edge. Repeat behind.



20. Complete the rounding by folding the back straight across, and rounding slightly. The bottom should not be a full circle, but like the simplified view on the right.



21. To complete the feet fold the flaps diagonally in front and back. The folds should be as close to the center as possible at the bottom and creased very sharply.



22. This is a simplified view of just the back of the foot. Tuck the two flaps inside to lock the foot in place. Repeat on the other foot.



23. Fold the flap down. Repeat on the other foot.



24. To complete the foot, fold the two flaps down. Repeat on the other foot.



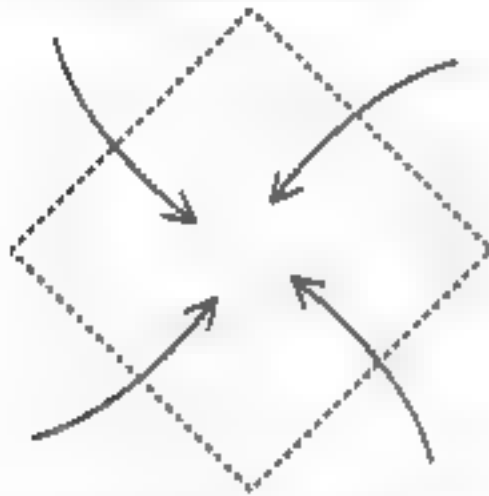
25. To complete the model, pinch the tail closed as the two views indicate and then curl the tail forward. The left view is the side and the right view is the front with the back flap removed.



26. Completed model.

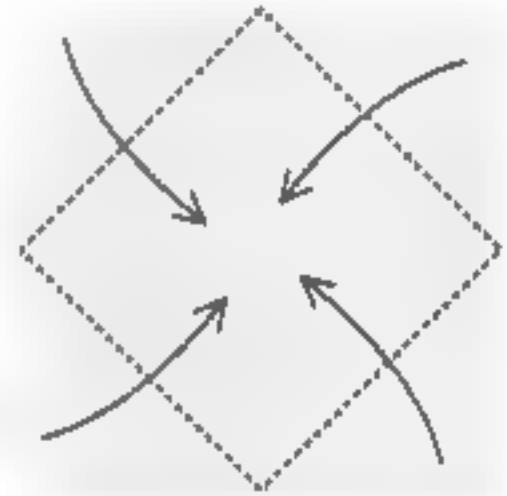
**Colored Lover's Knots** - The first of these was "Eights" which I created spontaneously from another model, a colored cootie catcher created by my friend Russell Cashdollar. Each of the steps for the base were taken directly from his piece. The "Lover's Knot" has always been one of my favorites, and after folding the first colored model, I endeavored to create other variations. These models can be folded from any type of paper. A 10" sheet will produce a 2 1/2" model in most cases. It is highly recommended that if you are not comfortable with folding lover's knots, you first try the basic version, which can be found in the "Inspirations" section.

## 1 - The Multi-Knot

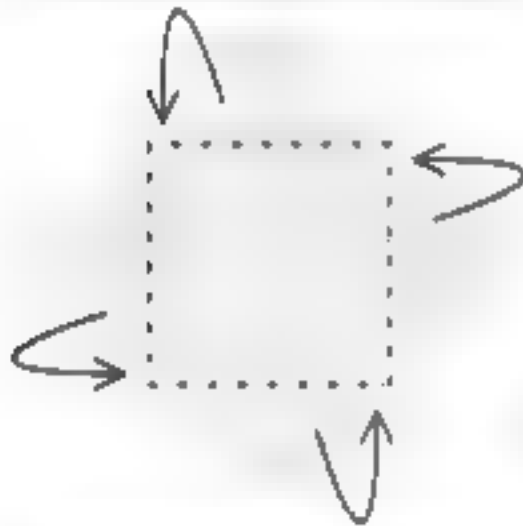


1. Fold all four corners into the center.

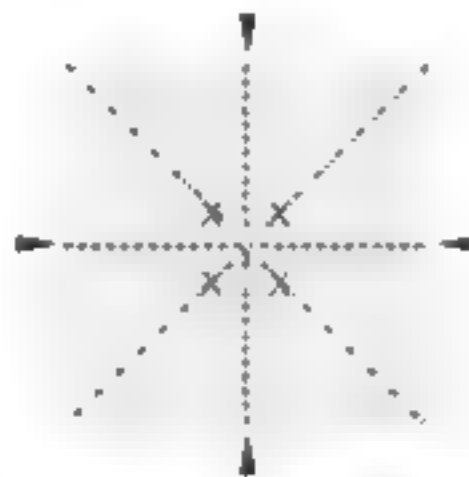
2. Turn the paper over.



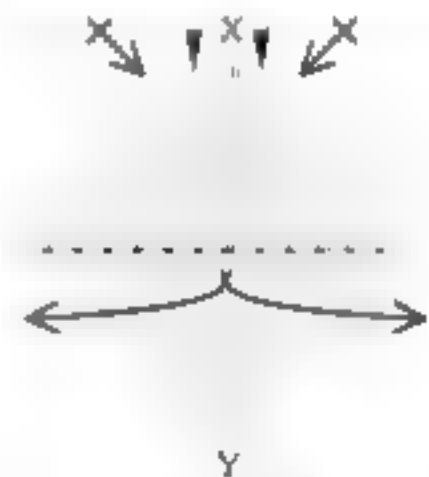
3. Fold all four corners into the center.



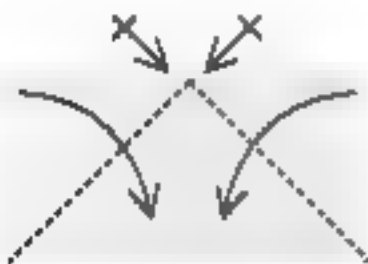
4. Repeat fold in the other direction.



5. Pinch the corners together, causing the points labeled X to pop upward, and the point labelled Y to pop downward.

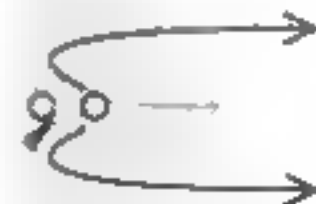


6. Squash fold the front two flaps. Repeat behind.



7. Fold the corners downward. Repeat behind.

8. Rotate the model 90 degrees.



9. Pinch all layers of the bottom triangle together with one hand, and all layers of the upper triangle together with the other hand, and pull the two sides apart, carefully spread squashing the center.



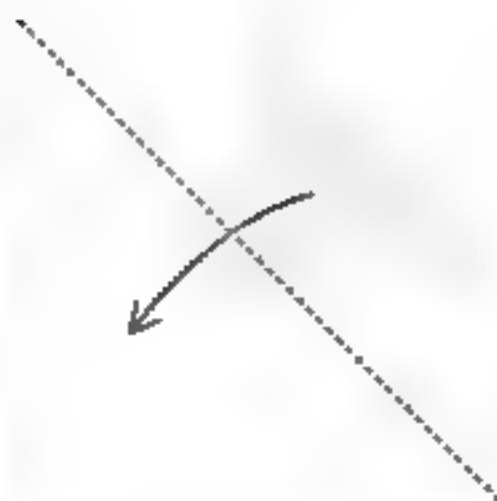
10. This is the completed "Multi-Knot". Each of the four tabs in the center can be opened, closed, or opened and tucked behind for a total of three possible positions. With four flaps, this gives  $3 \times 3 \times 3 \times 3$  or 81 combinations. Some of the more interesting variations are shown.



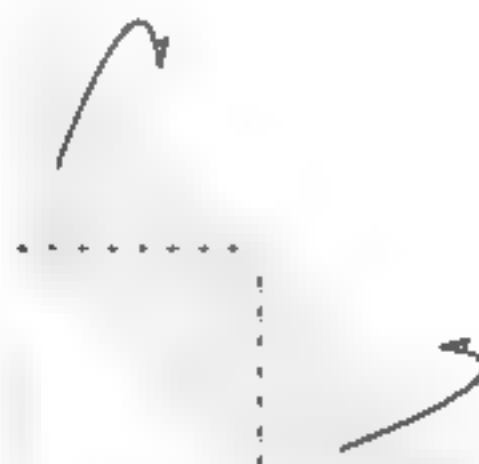
## 2 - Diagonal



1. Fold one corner in to the center



2. Fold the paper in half diagonally



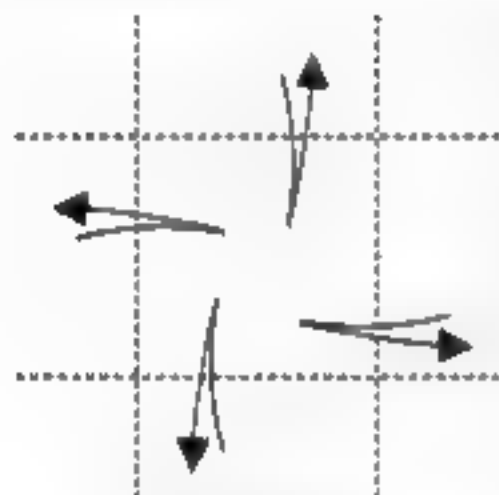
3. Fold the two points behind



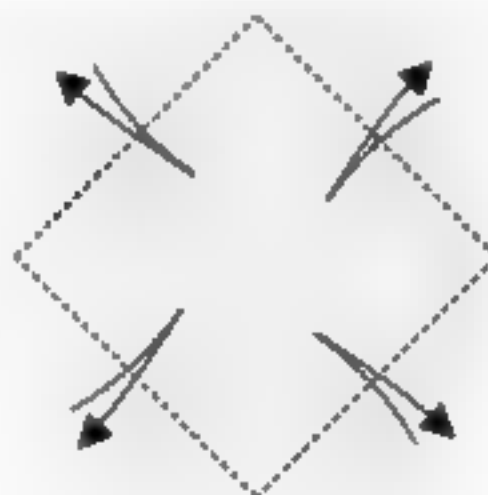
4. Execute steps 2-8 of the 'Multi-Knot' being very careful to not tear the paper on the final spread-squash step.

3. Completed model

### 3 - Squares



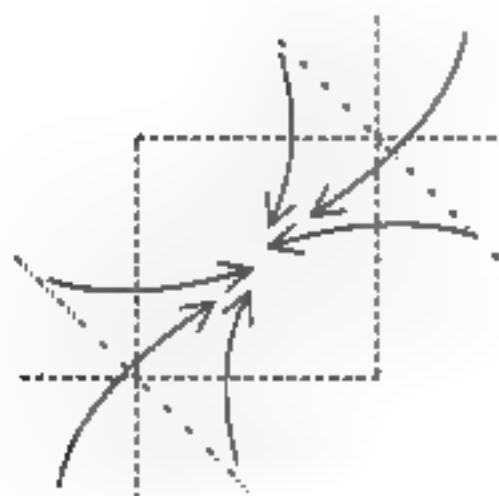
1. Fold and unfold. Turn the paper over.



2. Fold and unfold all four corners. Turn the paper over



3. Fold two corners behind



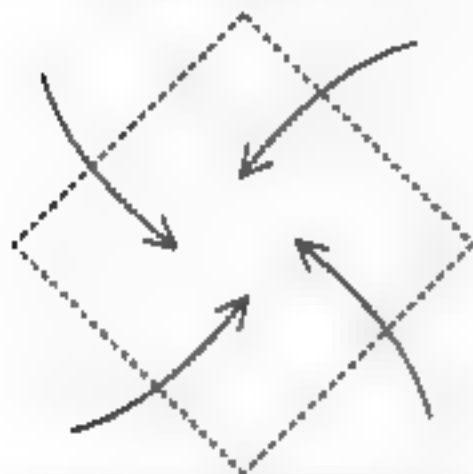
4. Fold two preliminary bases on the existing creases.



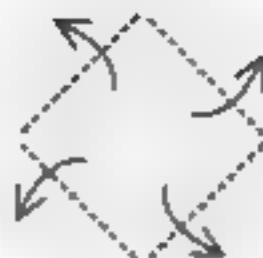
5. Execute steps 2-8 of the 'Multi-Knot', being very careful not to tear the paper on the final spread-squash step

6. Completed model.

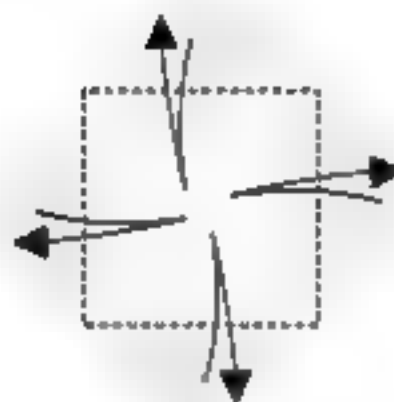
## 4 - Eighths/Windmill



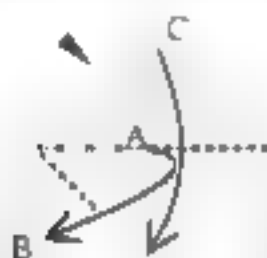
1. Precrease the paper diagonally and buntz fold the corners to the center



2. Fold all four flaps outward.



3. Buntz fold and spread the four corners.



4. Squash fold the flap, bringing point A to B.



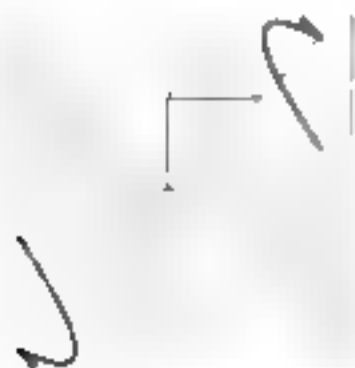
5. Fold the flap to the right.



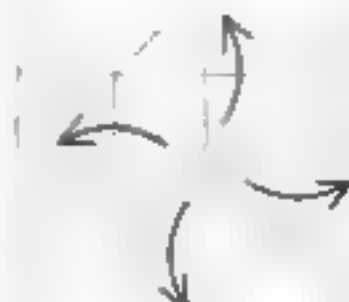
6. Repeat the last two steps on the remaining corners

7. Execute steps 2-6 of the "Multi-knot" being very careful not to tear the paper on the final spread-squash step

8. Completed model



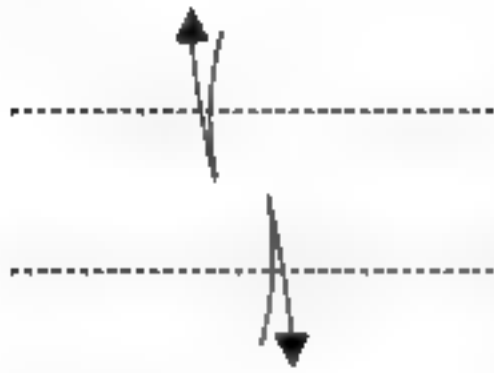
9. To create the "Windmill" fold the two white flaps behind the colored areas.



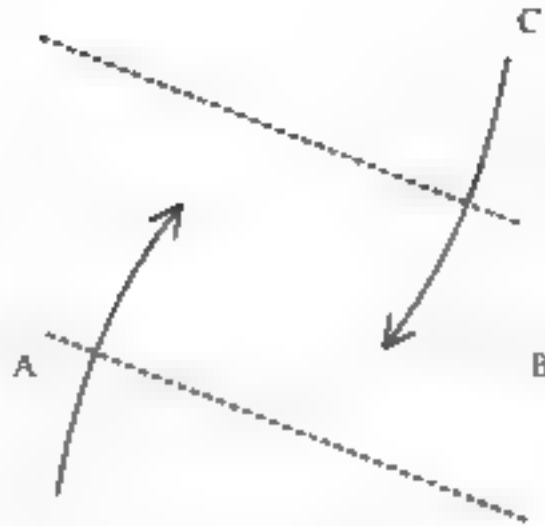
10. Fold each of the four flaps outward.

11. Completed model

## 5 - Stripes



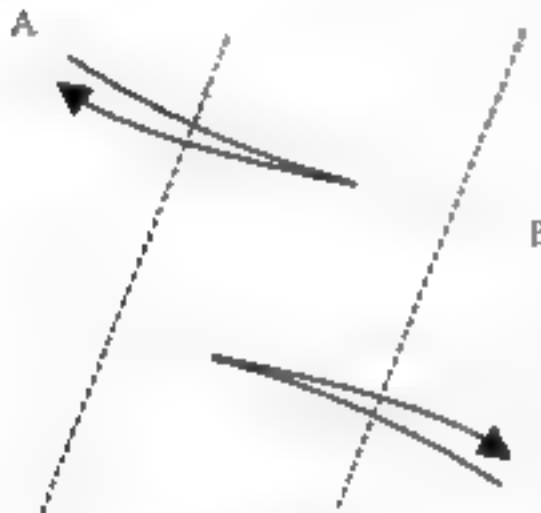
1. Precrease the paper horizontally in thirds.



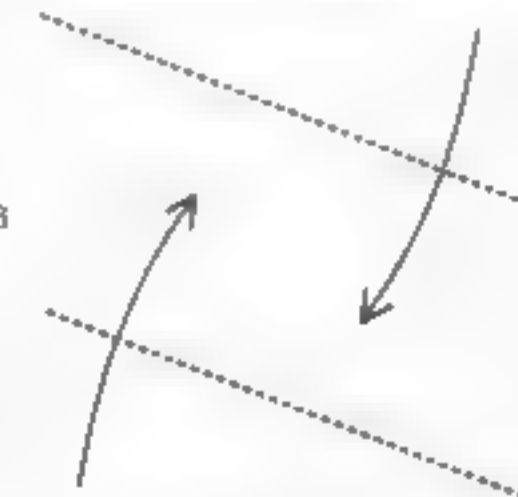
2. Fold corner C so that it meets line AB. Repeat on the bottom.



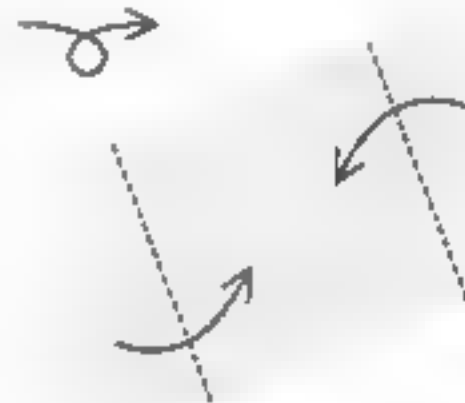
3. Unfold the flaps



4. Repeat with the other corners and unfold. Point A will lie on line AB.



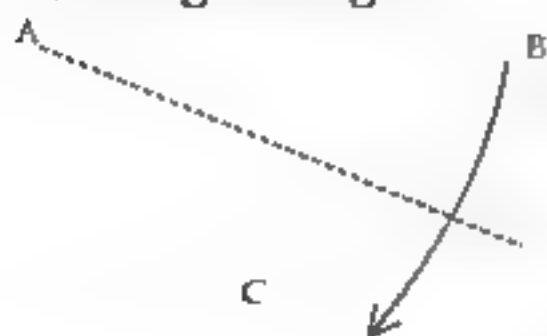
5. Repeat step two and turn the paper over.



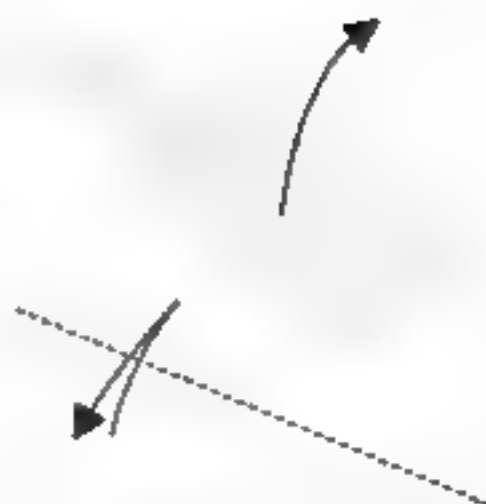
6. Fold the flaps in on the existing creases.

7. Four variations can be created by changing the orientation of the paper—either rotating or turning it over and working with the design on the back. For each variation, place the paper in the appropriate orientation and execute steps 1-6 of the Multi-Knot, being very careful not to tear the paper on the final spread/squash step.

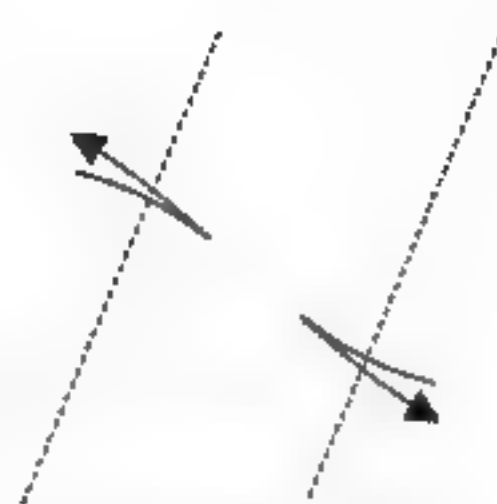
## 6 - Diagonal Eighths



1. Start with a square creased diagonally only in the center. Fold corner B inward so that AB intersects center C.



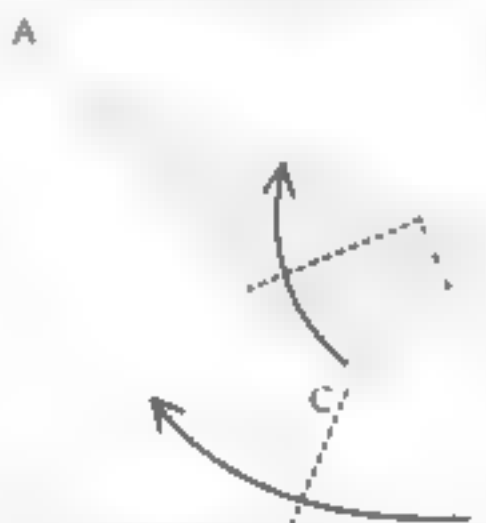
2. Repeat the fold on the other flap and then unfold both flaps.



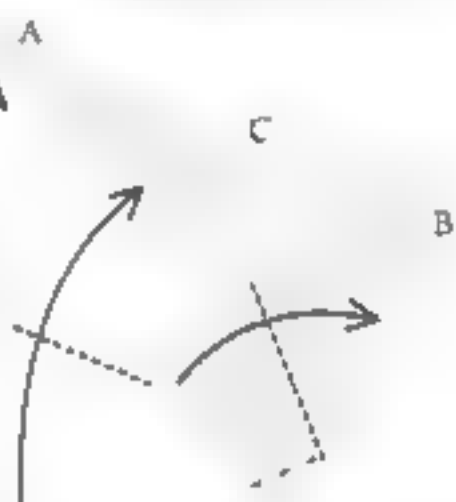
3. Repeat the previous two steps on the other flaps.



4. Fold the first flap back down



5. Swivel fold the next flap into place, swinging point C up to lie on line AB.

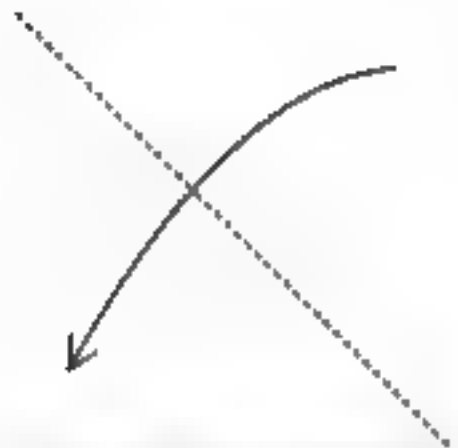


6. Repeat the previous step on the remaining three flaps, weaving the center together like the top of a cardboard box



7. Two variations can be created by either reverse folding or mountain folding the four tabs. For each variation make the appropriate folds and execute steps 2-6 of the 'Multi-Knot' being very careful not to tear the paper on the final spread squash.

**Leaping Lizard** - This was the first model in which I tried to use the topological approach to creating, where one lays out on the paper exactly where each part of the model will come from first and then folds from there. The first version of this model took about ten minutes to create. Finding a way to fold it that I could diagram took much longer. The model was named by Russel Cashdollar, who also came up with the idea of balancing it on its feet. The model can be folded from any type of paper. A 10" piece of paper produces a model 8" in length.



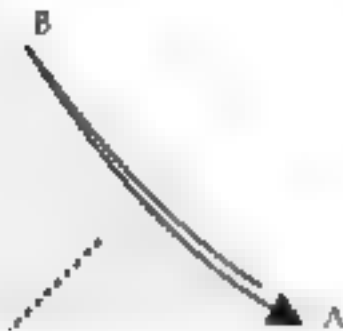
1 Fold the paper ~~in half~~ diagonally.



2 Fold and unfold the paper half, creasing only the top half of the paper.



3 Crease the diagonal only up to the previous crease and unfold.



4 Fold and unfold, bringing A to B so that the crease exactly intersects the meeting of the previous creases.



5 Crease vertically at the point where the previous crease intersects the bottom edge of the paper.



6 Square fold the flaps in by creases.



7 Reverse fold the two flaps.



8 Turn the model over.



9 Fold and unfold.



10 Fold and unfold bringing A to meet B at the center line.



11 Squash fold on the creases



12 Squash fold the flap.



13 Petal fold the edge.



14 Fold the flap down



15 Fold the flap down.



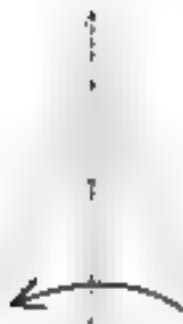
16. Repeat steps 12-15 on the other flap.



17 Carefully fold and unfold.



18 Squash fold on the creases.



19 Fold one large flap to the left



20. Squash fold, bringing point A to B. This is similar to a petal fold.



21 Swing the flap back down.



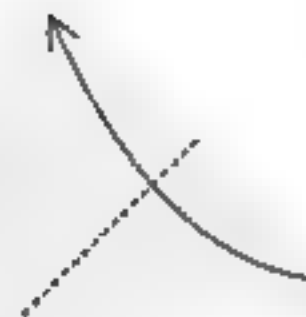
22 Fold the flaps back



23 Repeat steps 19-22 on the left side



24 Untold the top flap.



25. This is an enlarged view of the top of the model. Fold the flap upward.



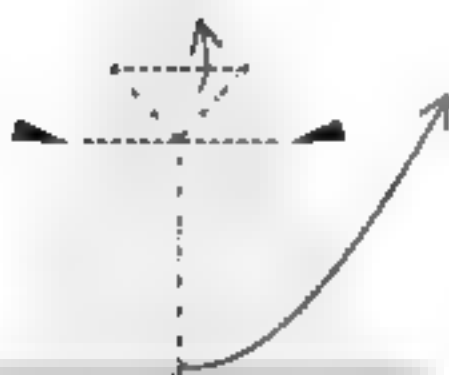
26. Very carefully execute a rabbit ear on the flap



27 Fold and untold the small flap. then untold to step 25.



28. Now we will fold a quadruple rabbit ear on the flap. This maneuver is simple once you learn it. Squash fold the flap



29 Continuing the quadruple rabbit ear push the sides inward and swing the flap up and to the right, forming half a bird base on the flap



30 Squash fold the flap



31 Complete the bird base and the quadruple rabbit ear by petal folding upward





32. Fold and unfold simultaneously along the two indicated lines. The paper will not be flat as you do this.



33. Pleat sink the not quite triangular area created by the creases in the previous step.



34. Repeat the sink on the other side of the model.



35. Fold the flap outward as far as it will go without distorting the model.



36. Fold the flap in half in the other direction.



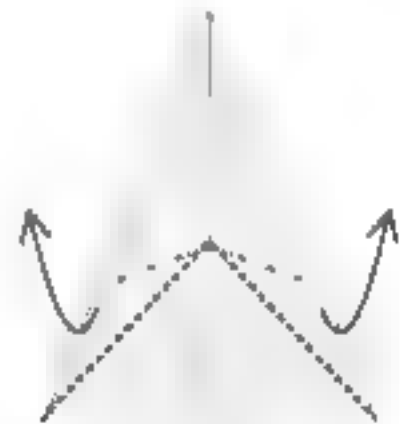
37. Reverse fold the point as far as it will possibly go, allowing some loose paper to pull out as you fold, and arranging things so that they do not brush the edge of the paper.



38. Thin the arm further with four reverse folds. If any paper is astray, just mould it into position with your thumb and forefinger.



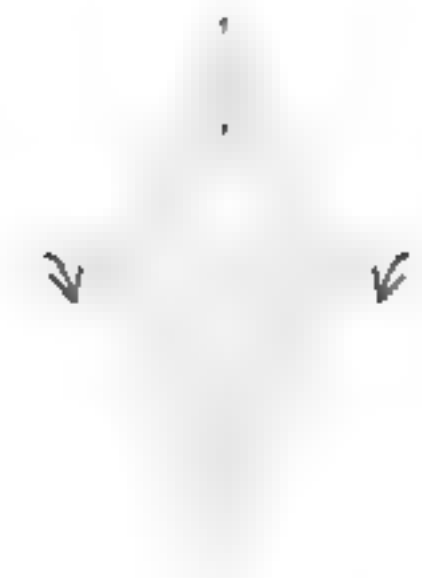
39. Repeat steps 35-38 on the other side of the model.



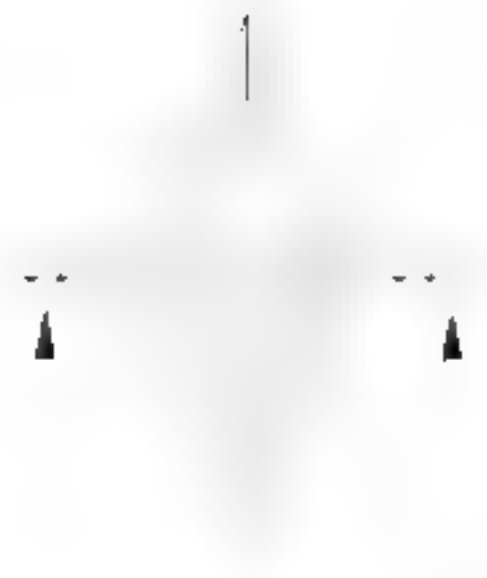
40. Reverse fold the two flaps at a slightly oblique angle.



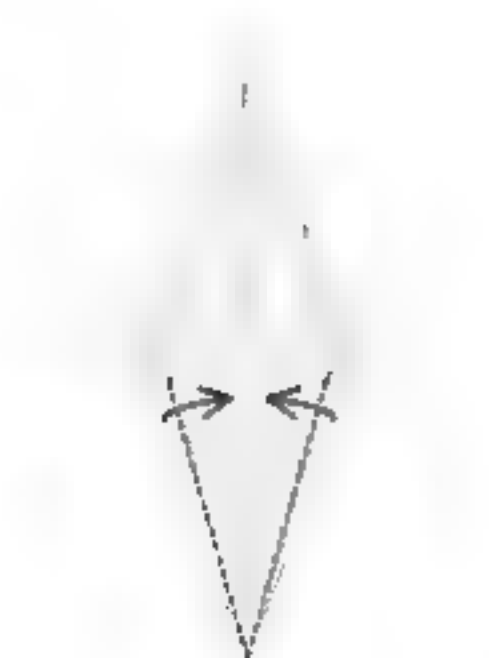
41 Reverse fold the two flaps.



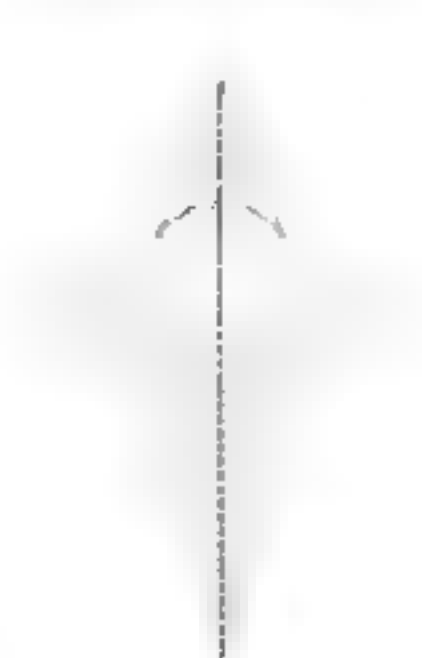
42 Correct the leg color by pulling out the loose paper



43 Reverse fold the legs again.



44 Fold the two flaps as far inward as they will go.



45 Fold the entire model in half creasing VERY sharply if you aren't using foil paper



46 Reverse fold the head

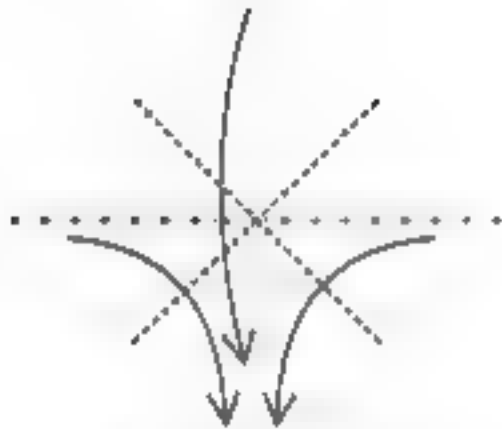


47 Complete the model by pulling down three layers on either side of the head, and positioning the lower jaw



48 Completed model. Now balance the model on its feet

**Fairy** - This model was created one night in a fit of passion brought on by the fact that I hadn't created any original models in quite some time. I felt a great need to prove to myself that I could still do it. The model was inspired by a very similar two piece version by Yoshihisa Kuroda which appeared in the F O C A National Convention '92 Annual. The original was created in under an hour but it took me several months to recreate the effort. A 6" piece of paper produces a 3" model with a 4 1/2" wingspan. It can be folded from any type of paper but fo works best. It also works exceptionally well in miniature.



1. Start with a preliminary base.



2. Petal fold the front and back flaps.



3. Fold the two flaps down.



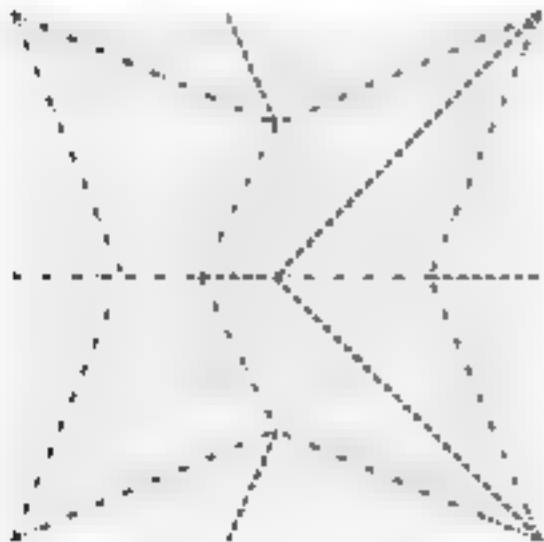
4. Fold one flap to the right.



5. Fold and unfold.



6. This fold is similar to a sink, but as you execute the fold, bring the two inner flaps to the right.



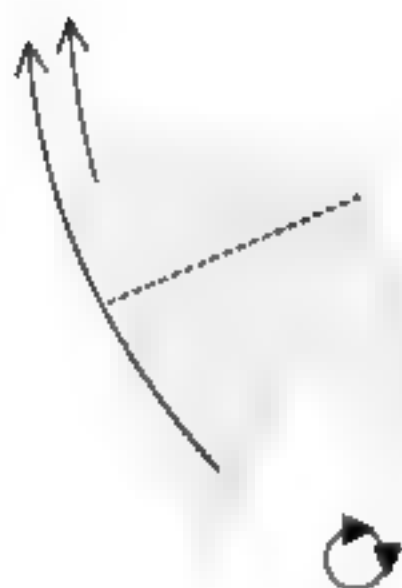
(This is a construction map of step 6)



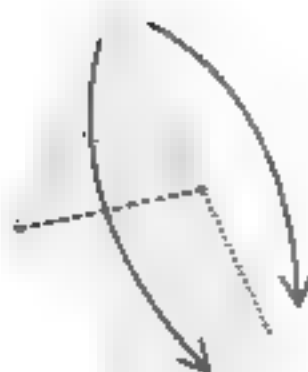
7. Spread squash the flap.



8. Fold the flap back up.



9. Fold the flaps upward.



10. Fold the flaps down. Use the corner of the hidden area, indicated by the dotted line, as a guide



11. Fold and unfold. Turn the model over



12. This step can be somewhat vague, but it is not difficult once you understand what is being done. Pinch the model together at point A and carefully reverse fold, keeping ridge AB tightly closed. This may be easier if you insert a finger inside the model where indicated by the arrow. See step 17 for an intermediary view of the fold



13. Fold the flaps back up



14. Reverse fold

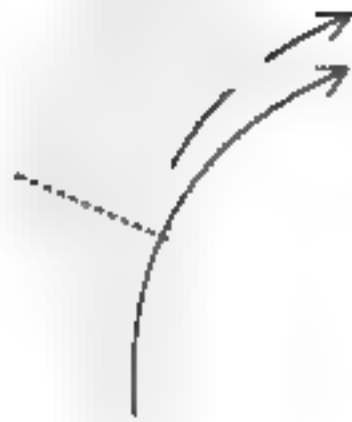


15. Reverse fold the flap again.



16. Open the top of the model and flatten out the wings.

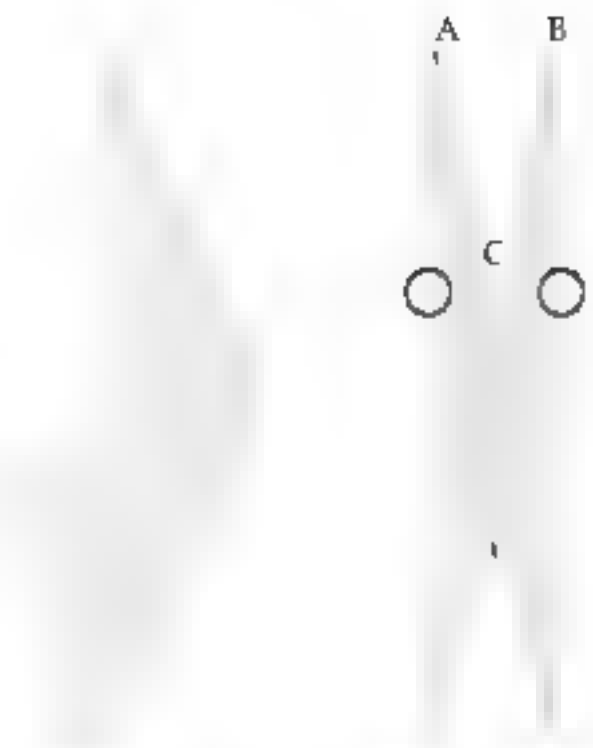
17. This is a view from the top of the model. Using the existing creases as a guide, tuck the entire dark gray area underneath the wings. To accomplish this, the entire darkened region will need to be crushed into a compressed ridge just under the edge of the wing, as shown in the second illustration. Close the wings again.



18. Valley fold the flaps in front and behind.



19. Fold the flaps back down. Rotate the model 180 degrees.



20. Like this. The second view is from the front of the model. Grasp the edges of the paper where shown and gently open the paper. The model will become 3D.



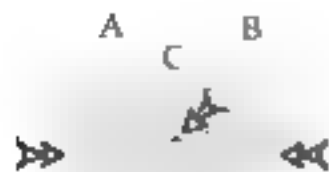
21. This is a 3D view of the opened model. Put the mountain fold creases into place by pushing the indicated points upward from underneath.



22. Push the two side flaps back into place, flat against their adjacent layers.



23. Do the same with the other side. As you do so, points A and B will swing naturally toward each other.



24. Complete the construction by closing the model as indicated.



25. Fold and unfold. Repeat behind.



26. Sink, repeat behind. This fold is easier if you unfold the triangular flap substantially.



27 Crease through all thicknesses.



28. Like this, and untold



29 Crimp, bringing the outside layers to either side, and the central layer through the middle. The extra ridge attached to the central layers can fall to either side



30. Mountain fold, if the paper is stiff enough to hold the crease. otherwise sink. Repeat behind.



31 Reverse fold the two flaps.



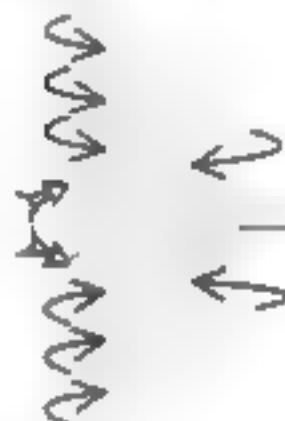
32 Rabbit ear each of the arms



33. Flatten out the wings again.



34. Grasp the paper firmly where indicated and gently pull the front of the wings partially apart.



35 Flatten out the paper that is sticking up in the areas indicated by the open arrows. Curl the front edge and rear of the wings upward



36. Flatten the point and curl it downward



37 This model has two options for the head. This stylized version is the first. If you like it, skip ahead to step 39. Otherwise, pull down the extra paper from both sides of the head.



38. Sculpt the head into final form

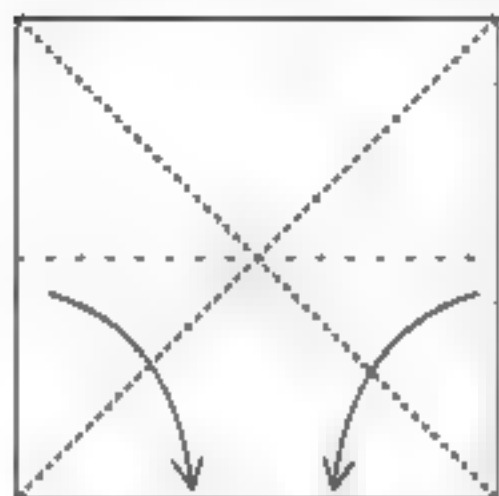


39 Crimp the legs upward.

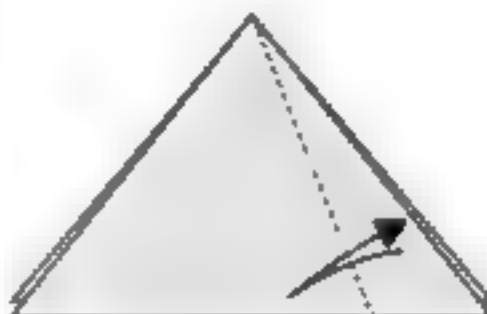
40. Completed model.



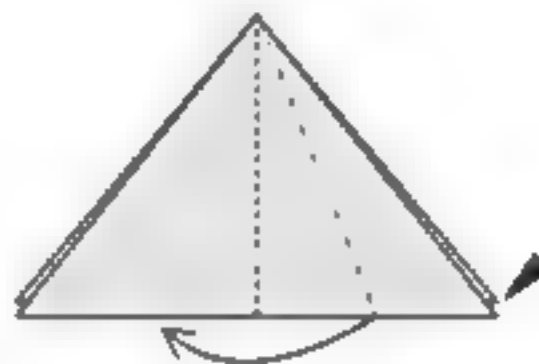
**Postscript: Dragonfly** - Originally I'd wanted to complete this book with an updated version of the "Dragonfly" model. Unfortunately, I didn't work out that way. Deadlines and my schedule prevented the re-work. But in late '95, after the book was published, I found the time. So I've included the revised version here as a postscript to the entire book. Fold the model from a square of Japanese foil or other very thin material. This model is not easy! It requires the folder to do some creative interpretation at some points. A 10" piece of paper produces a model 4" in length.



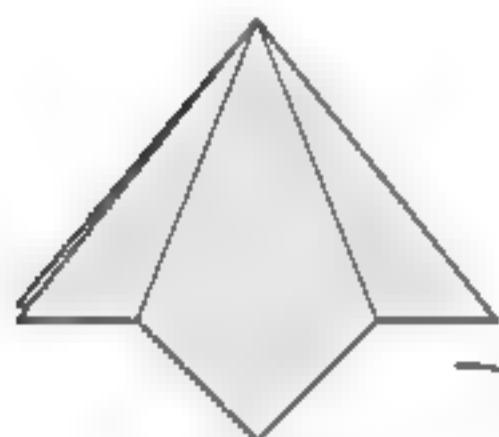
1. Start by folding a waterbomb base, colored side out.



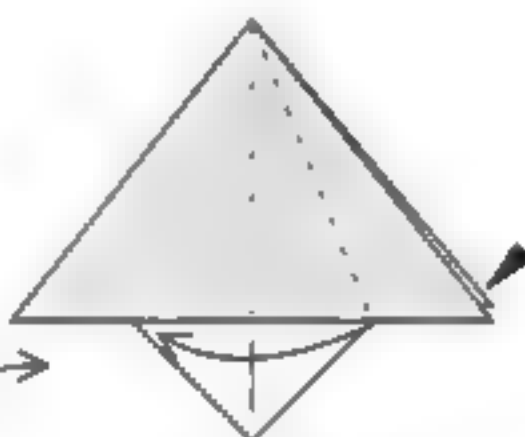
2. Fold and unfold the flap.



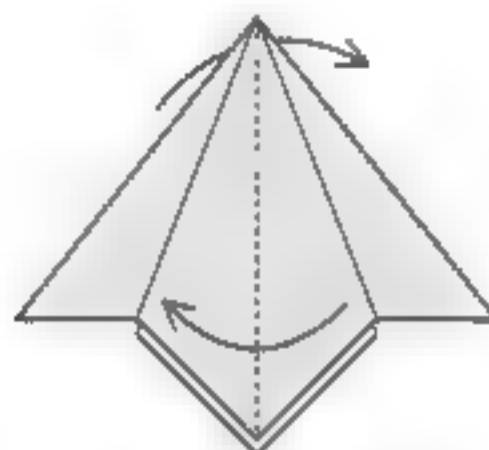
3. Squash the flap



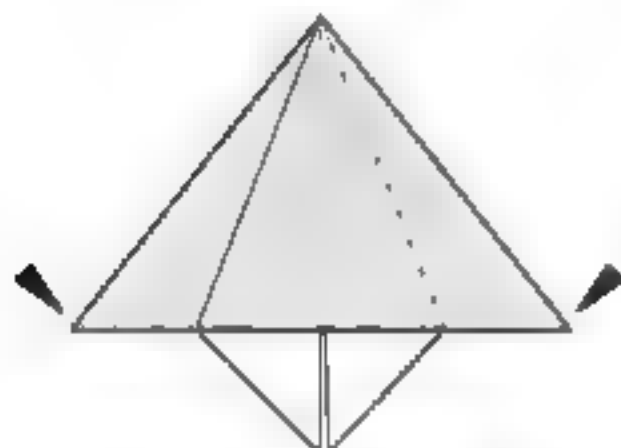
4. Turn the model over.



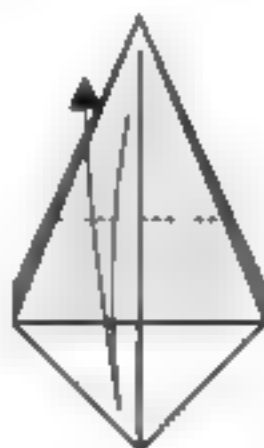
5. Repeat the squash fold.



6. Fold one flap from left to right in front and behind.



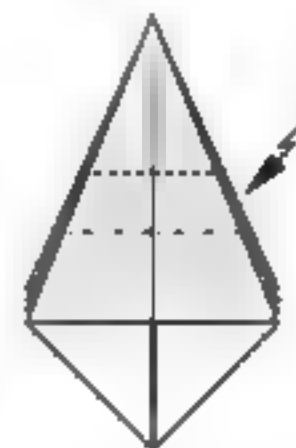
7. Repeat steps 2-6 on the remaining two flaps in front and behind.



8. Fold in half and unfold.



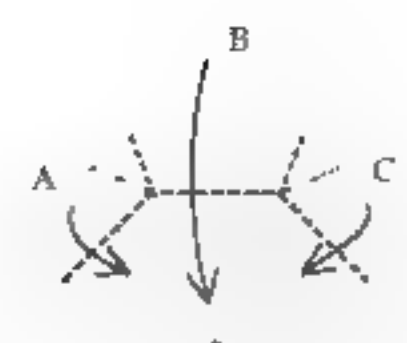
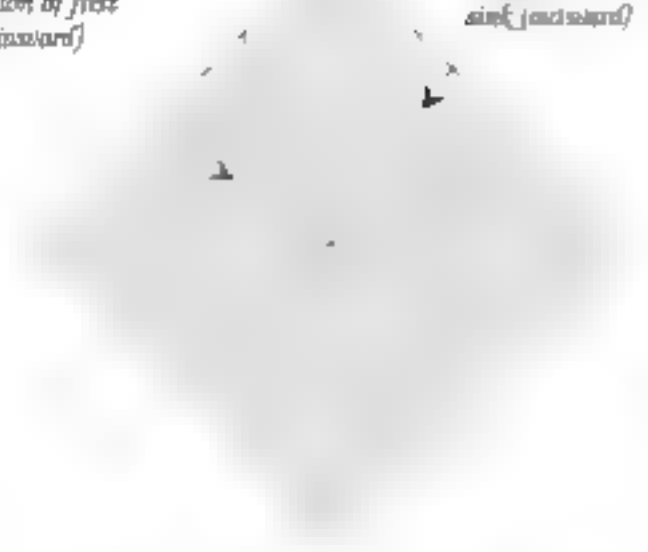
9. Fold the tip down to the edge of the paper and unfold.



10. Execute a crimp sink on the two creases. The following steps detail the procedure.

Location of first sink (inward)

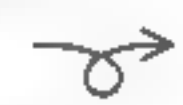
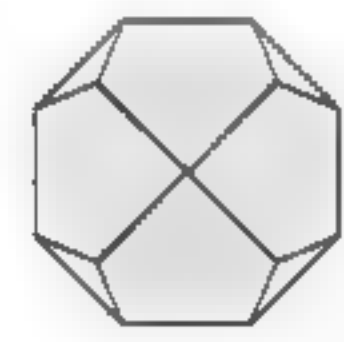
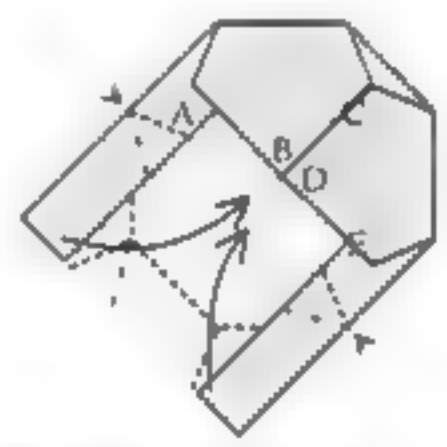
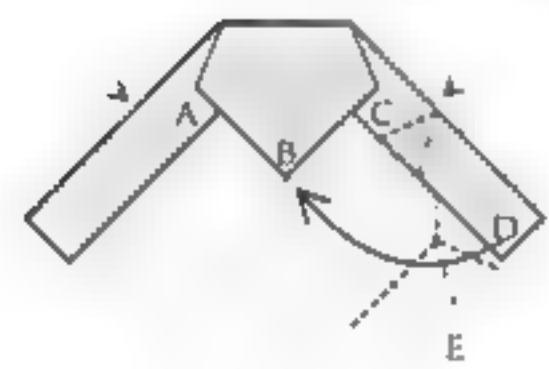
Location of second sink (outward)



10a. Unfold the model completely. Note the locations of sinks to be executed. Turn the paper over

10b. Bring the three points in to the center on the existing creases, folding the sides first (A & C), and then the top (B). Don't worry about the lighter lines, just do the dark portions and the others will follow naturally

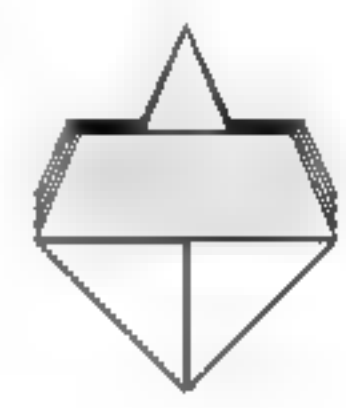
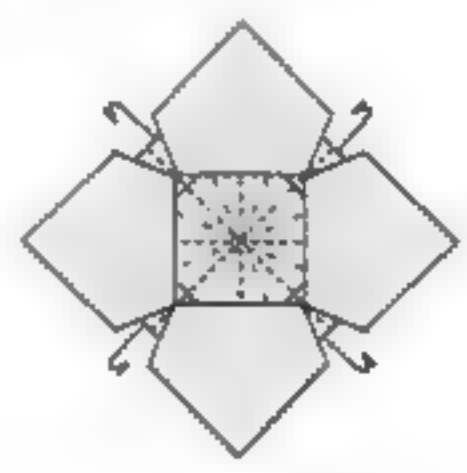
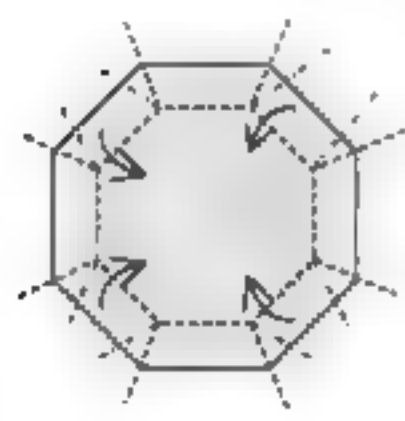
*Note: The creases on the sides will only come as far as the arrows indicate. The model is shown flat to clarify the folding procedure but is actually 3D.*



10c. Bring the next two points D & E to the center as in step 10b.

10d. Continue around the circle with the remaining points.

10e. Turn the model over

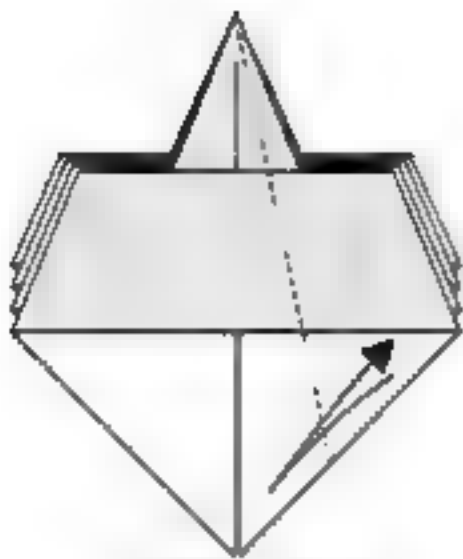


10f. Repeat the process on the next layer of folds, letting the flaps swing out from behind

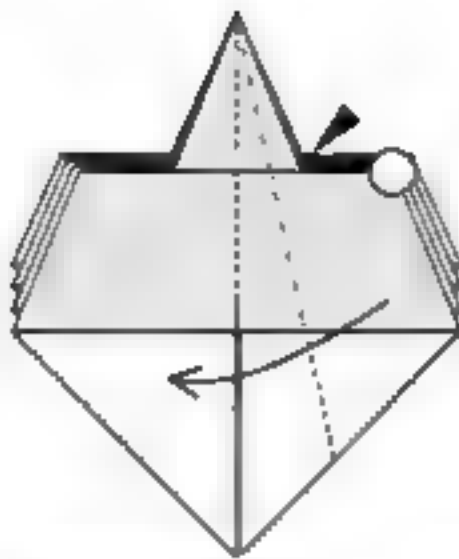
10g. Now, to complete the sink, fold the model up like a fan on the existing creases

11 This is a completed spider base, standard configuration

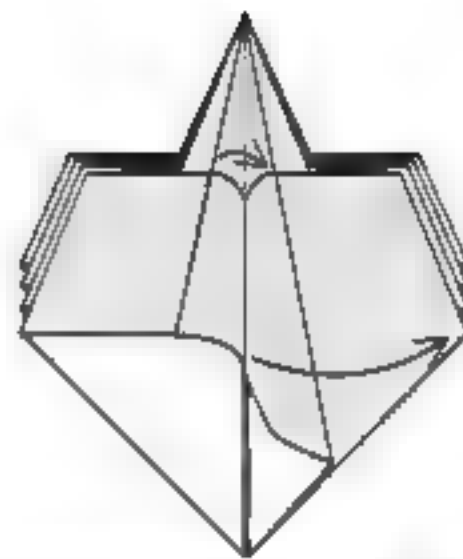




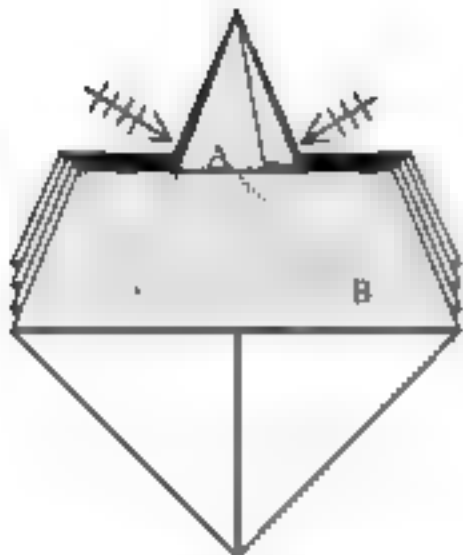
12 Fold and unfold all layers of the flap.



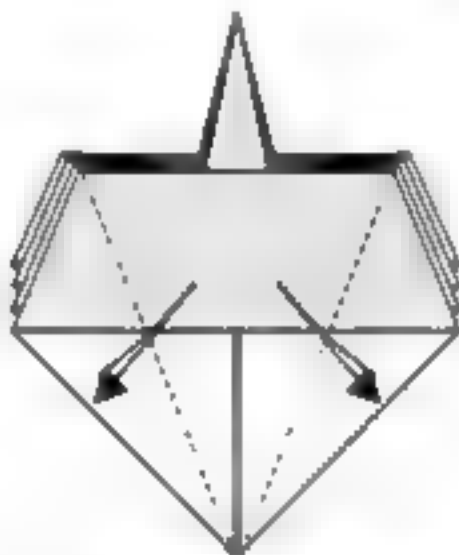
13 Pinch the flap where indicated and squash, flattening where the lines indicate, but not flattening the flap that you are pinching. The model will not be flat.



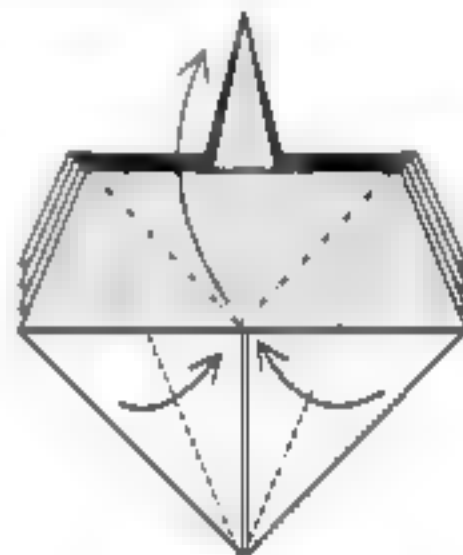
14 Now bring the flap back, keeping the squashed area flat, and pulling the raised area back into its previous position. An annoying third ridge of paper will appear between the two ridges (shown as AB in the following step) as you do this. Adjust the third ridge so that it matches the lines shown in the following illustration, sticking a finger inside the model and guiding it as you fold.



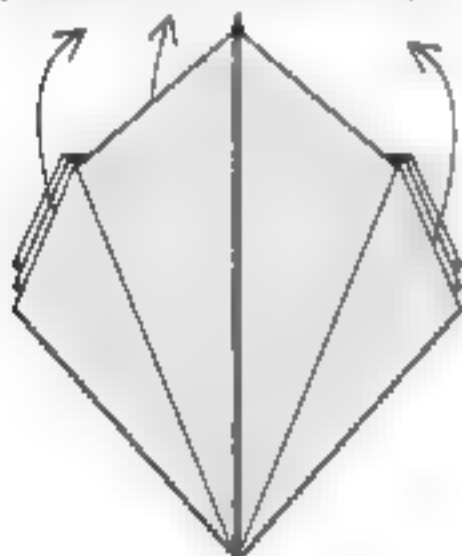
15 Completed squash. The dashed lines indicate an X-ray view of the hidden ridge and accompanying structures. Repeat the squash fold on the other seven flaps.



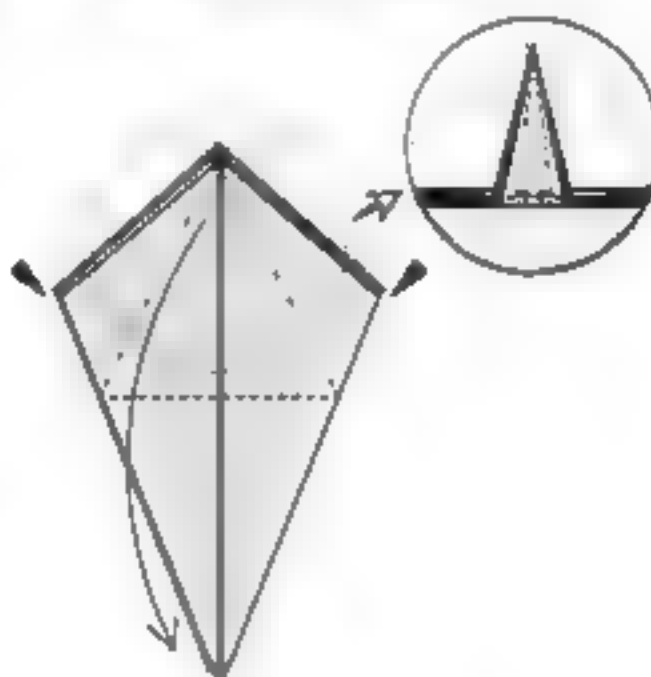
16 Prepare to double petal fold. Fold the flaps in and unfold.



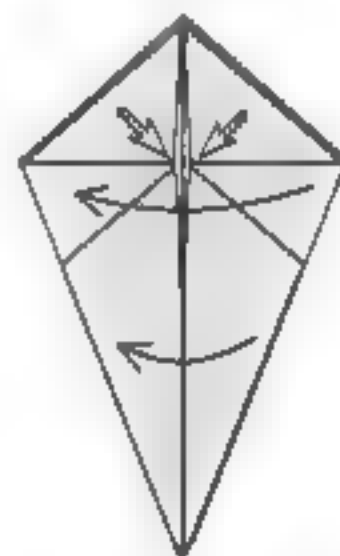
17 Petal fold upward.



18 Repeat the petal-fold on the other three flaps.



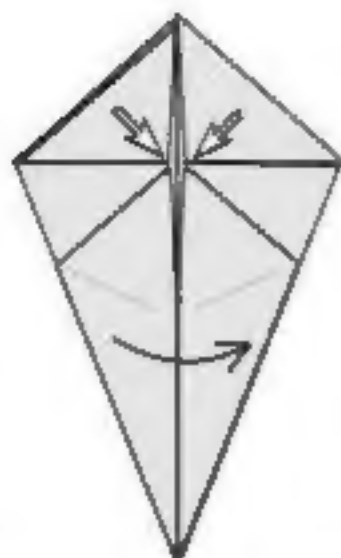
19 Petal-fold the flap downward, thinning the hidden layers as shown. This is not easy to do cleanly, so be as careful and accurate as possible.



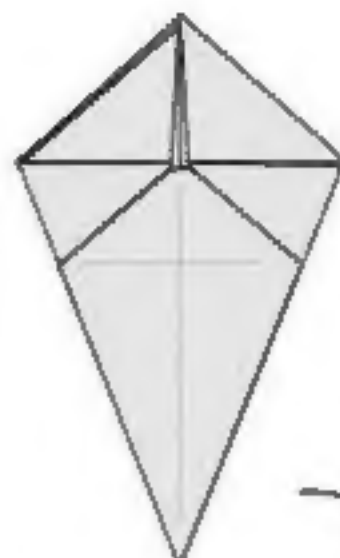
20 Mold the flaps folded in the previous step to make them as possible. Fold two flaps to the left.



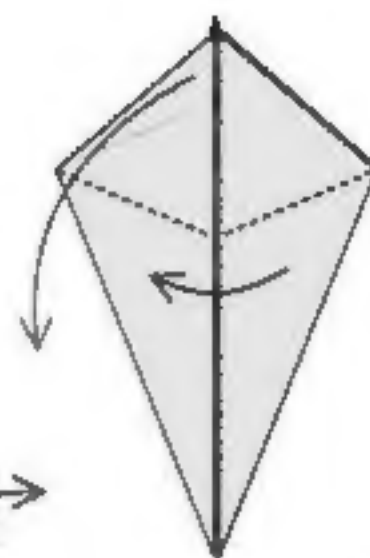
21. Repeat the petal fold.



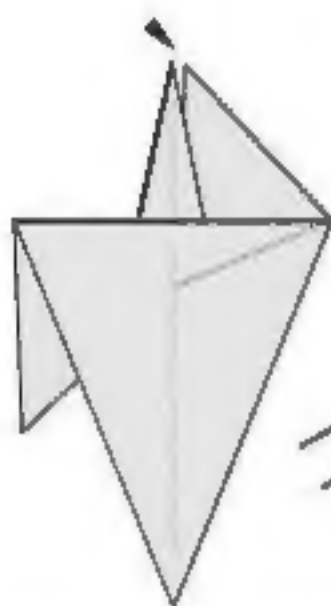
22. Mold the flaps folded in the previous step to make them as possible. Fold one flat to the right.



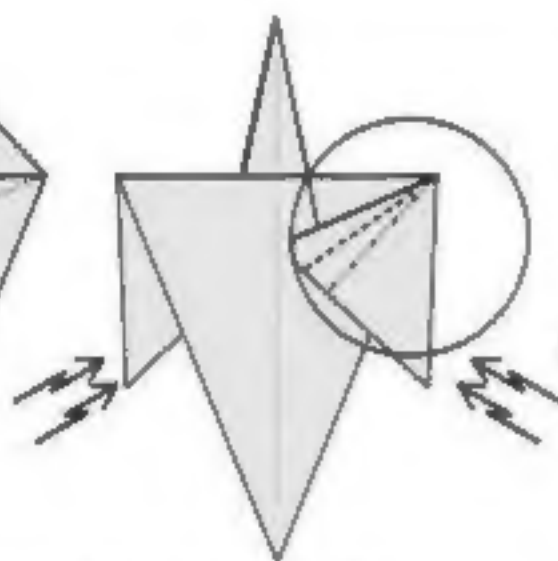
23. Turn the model over.



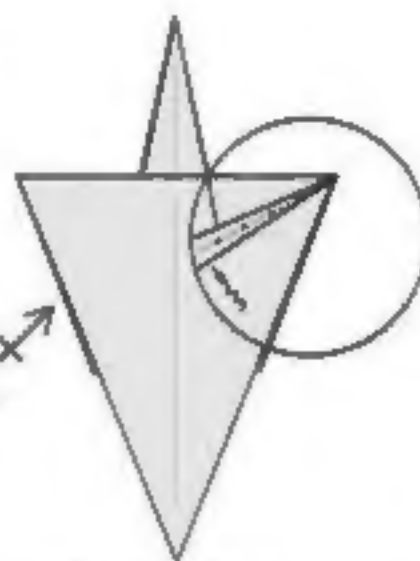
24. Fold one flap to the left incorporating the reverse fold on the existing crease.



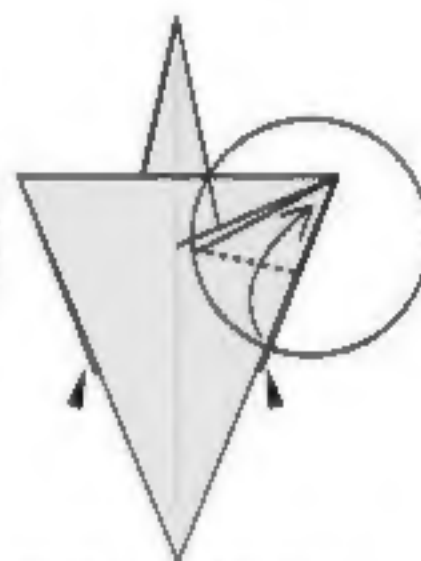
25. Incorporate the reverse fold on the other side.



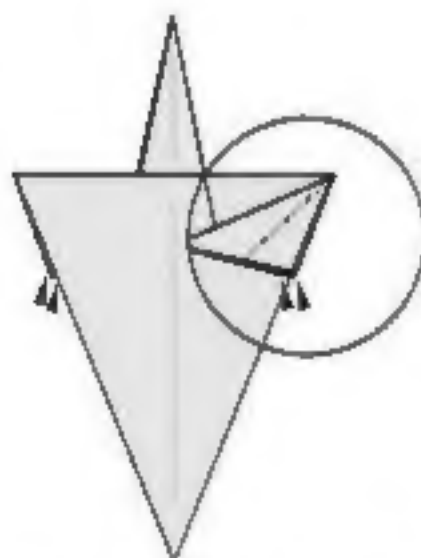
26. Cut away view. Crimp on both sides using the "other" inner crease as a guide.



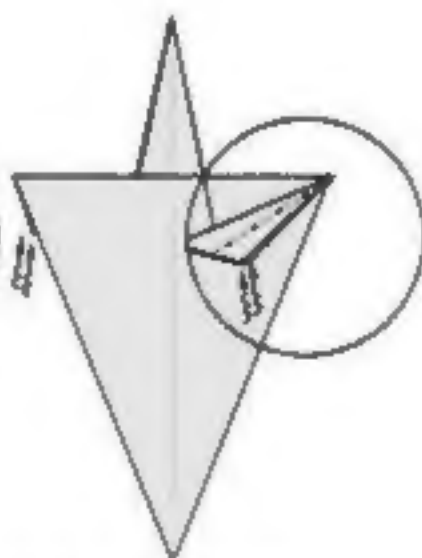
27. Thin the ridge that was formed with a "Pleat-Sink".



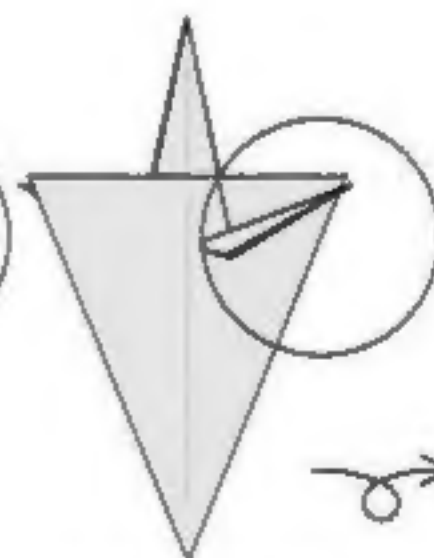
28. "Reverse fold" the large hidden flap in half on both sides.



29. Reverse fold both flaps in half on each side.



30. Thin each of the flaps in half by pleat-sinking.



31. Like this. All layers should line up and the "legs" should be very thin and even.



32. Sink twice on either side making the inside as clean as possible as you do so.



33. Sink the top layer.



34. Fold one layer to the left.



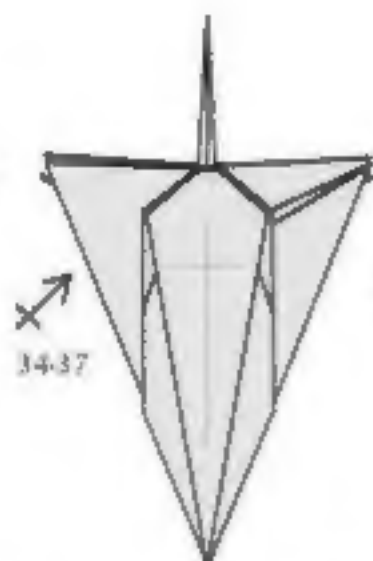
35. Reverse fold along the edge of the hidden leg. This is not easy and you may need to "wrap" some of the paper on the left to do it.



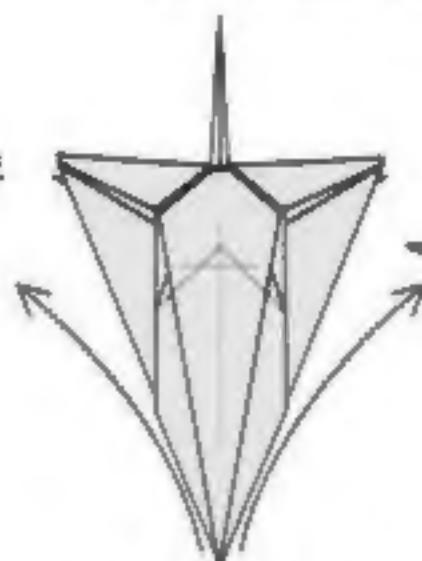
36. Reverse fold again.



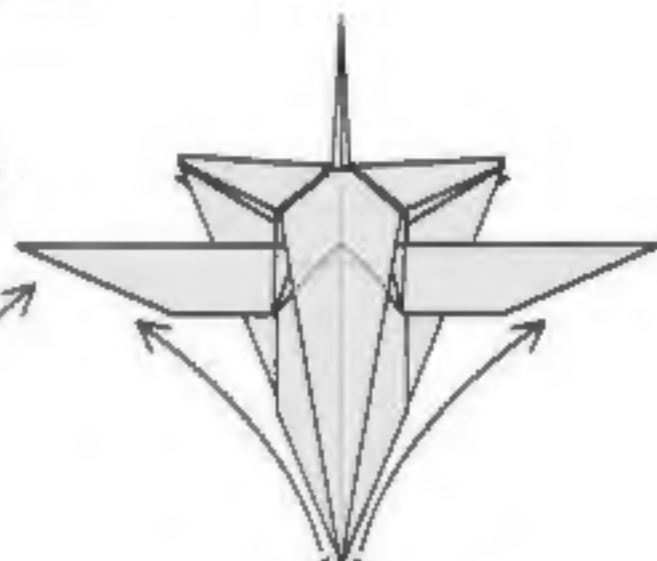
37. Fold a flap to the right.



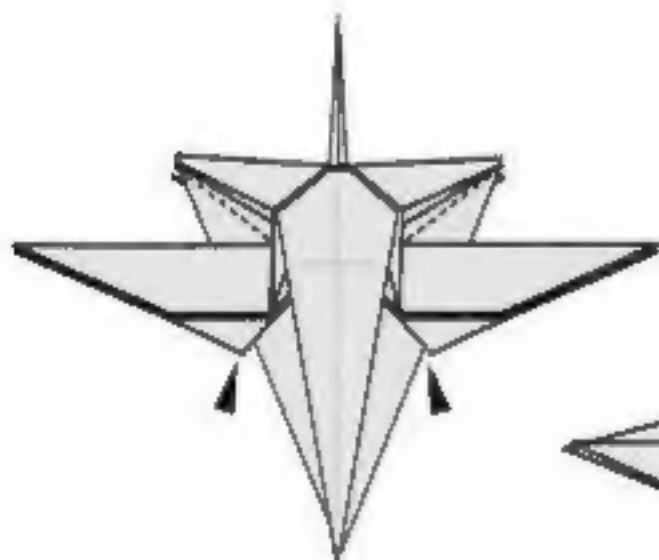
38. Repeat steps 34-37 on the other side.



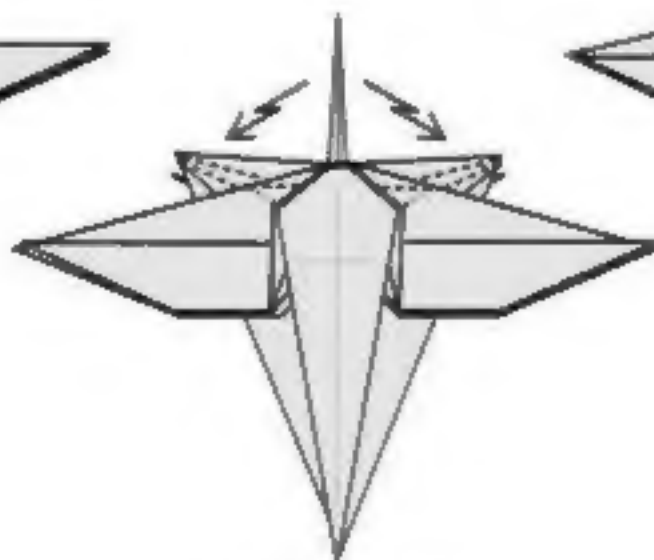
39. Reverse fold the upper set of points.



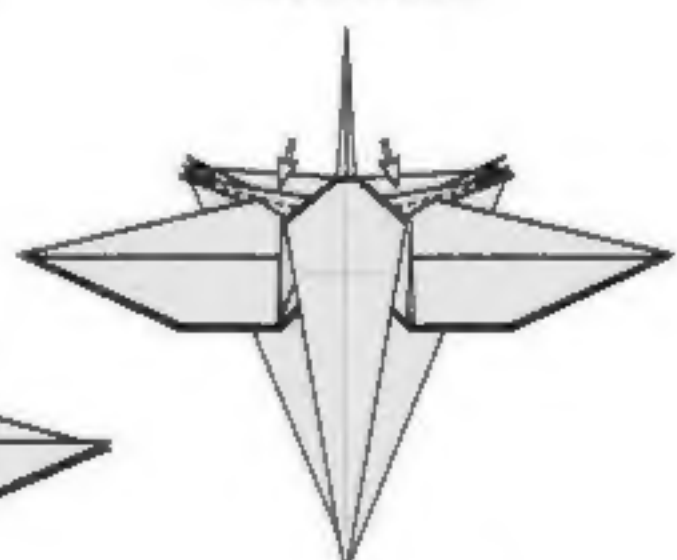
40. Reverse fold the next set of points.



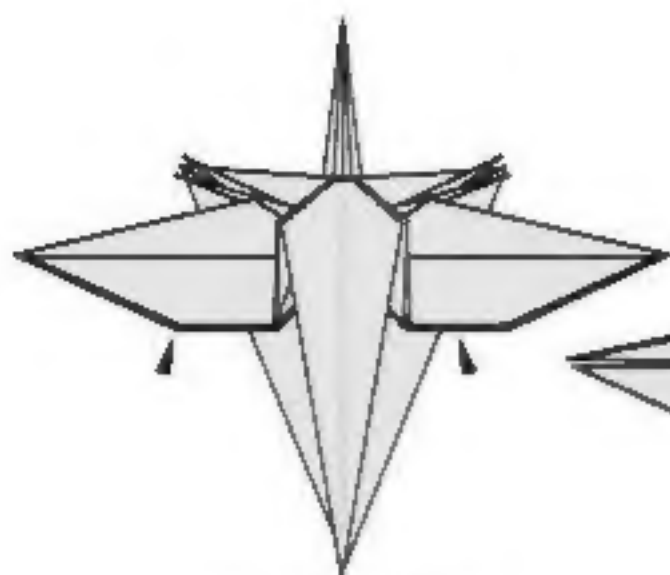
41. Reverse fold the back of the wings as far as possible.



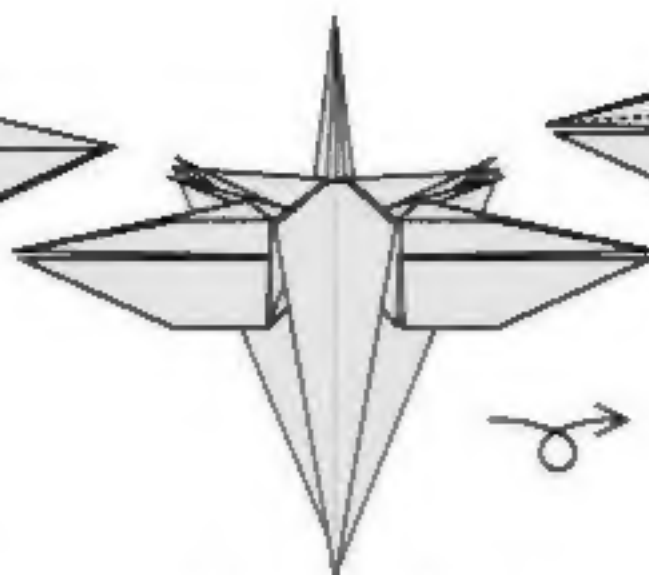
42. Flatten the flap in thirds along the edge of the leg.



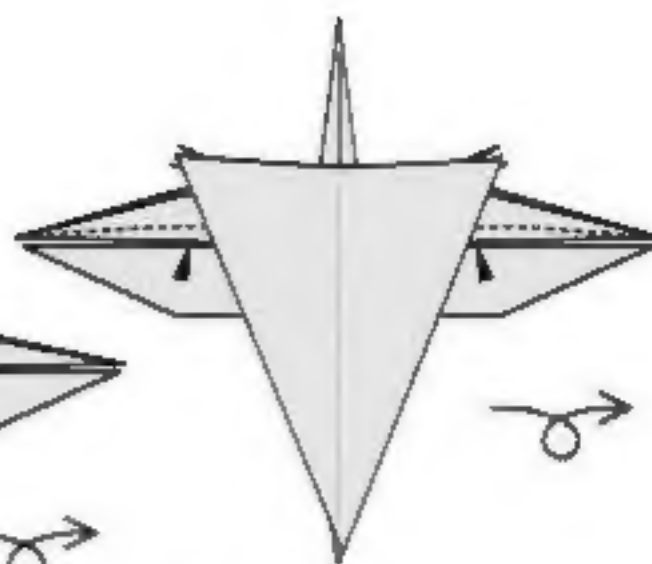
43. Complete the leg by pushing the extra layer over the others.



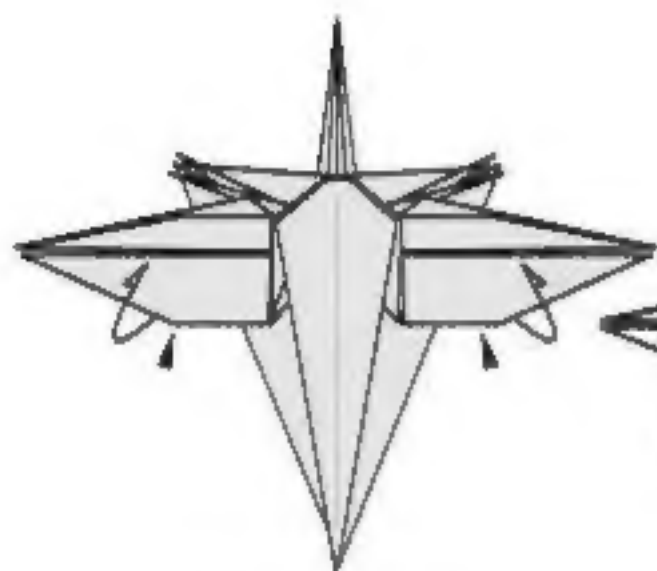
44. Reverse fold the other layer of the rear wing upward.



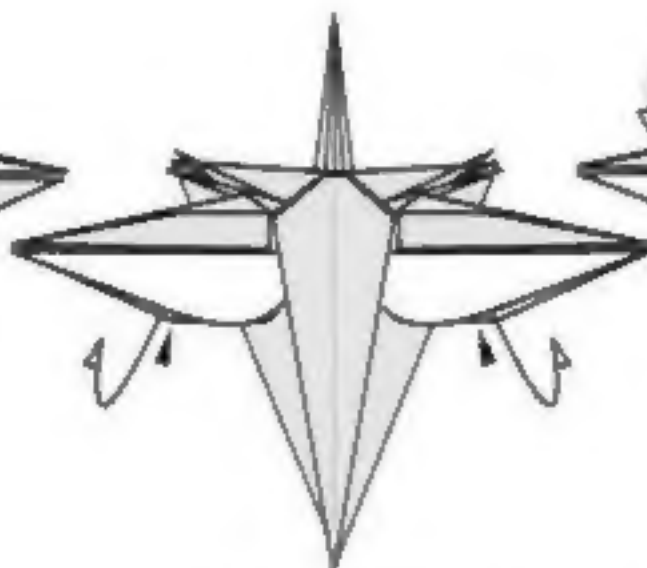
45. Turn the model over.



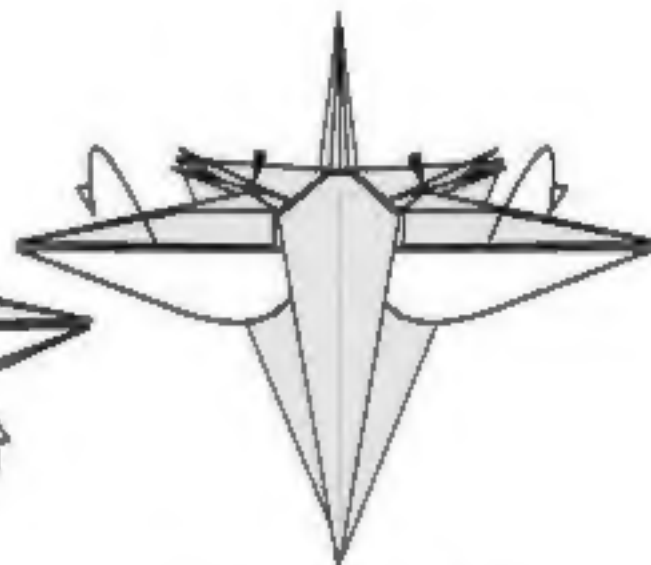
46. Push some paper up to expose some white and turn over.



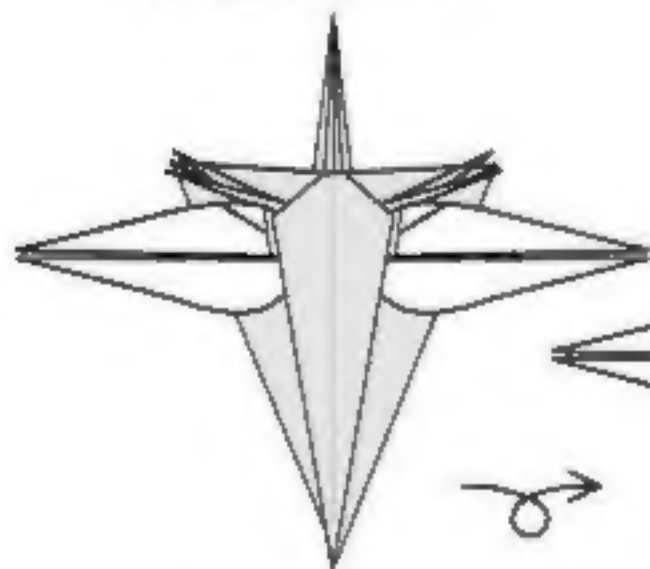
47. Carefully, wrap the colored layer around the top of the wings. As you do this liberate some of the paper which was lost in the sink in step 33.



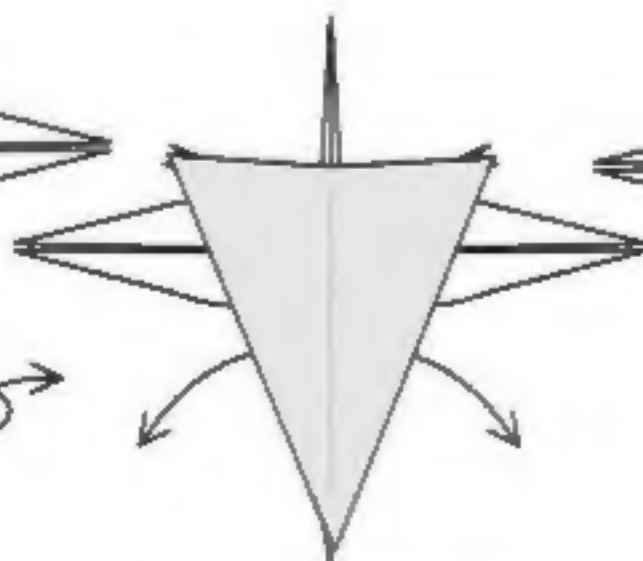
48. Repeat the wrap on the next layer of the wing, again using the encumbered paper to maximize and shape the wing.



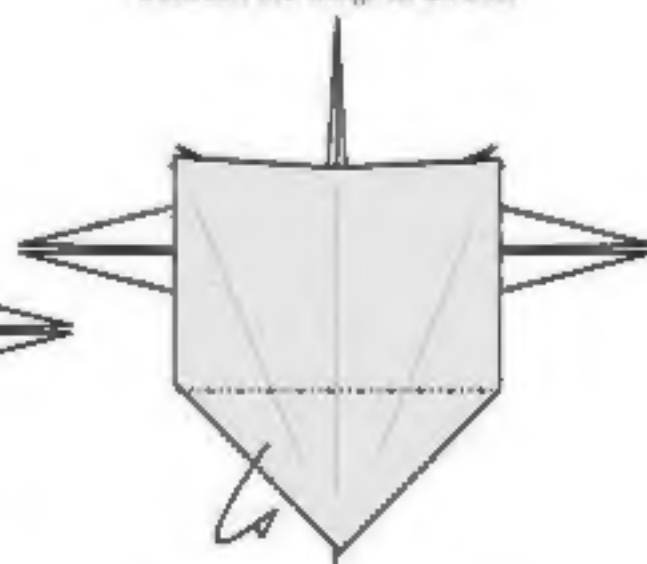
49. Wrap a final time, entrapping both layers of the upper wing. Make sure that the wing stays in the same position. You will need to play a little with the loose layers of paper, incorporating a sort of a "twist-fold" between the wings to do this.



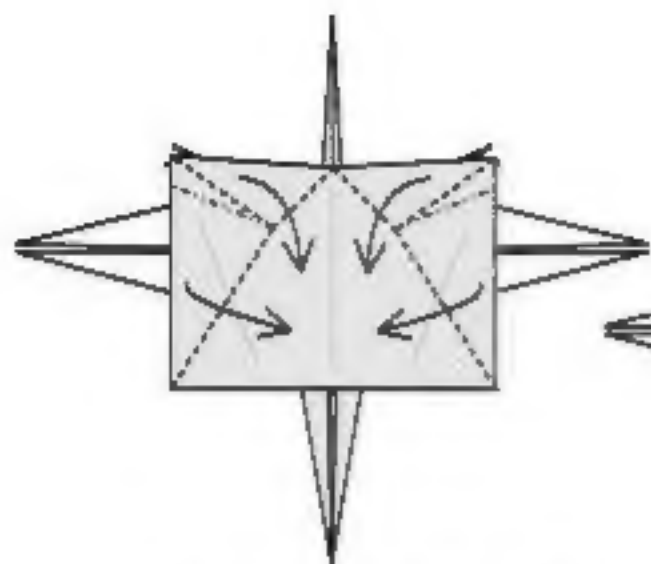
50. Turn the model over.



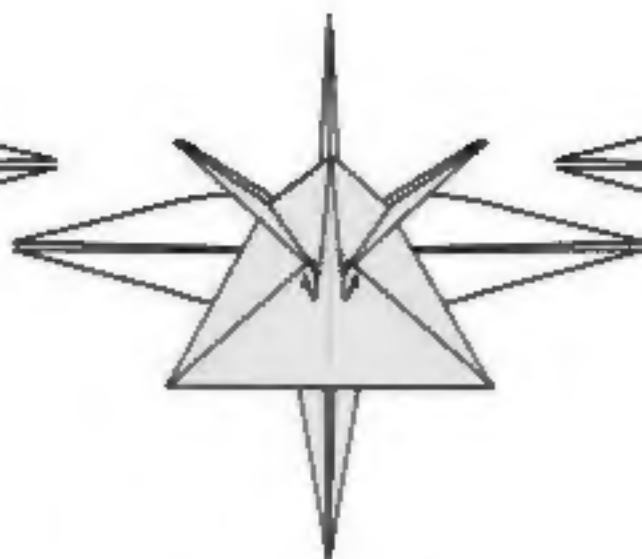
51. Carefully, slide out some loose paper.



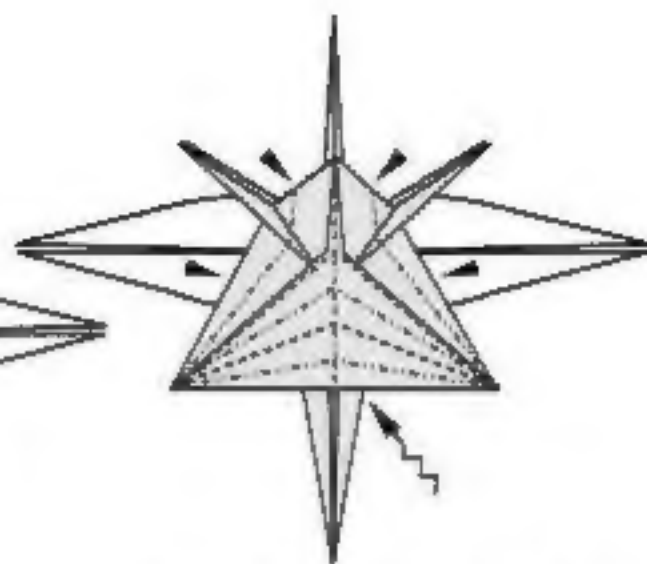
52. Fold the flap underneath.



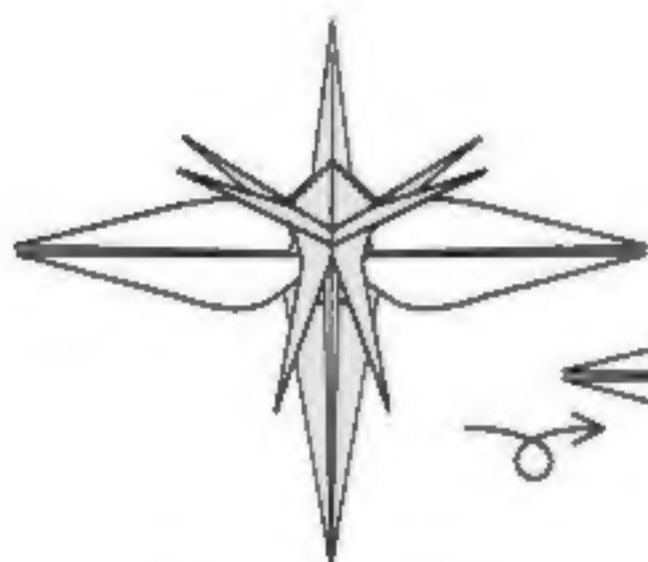
53. Similar to a rabbit ear. Use the structures behind as a guide.



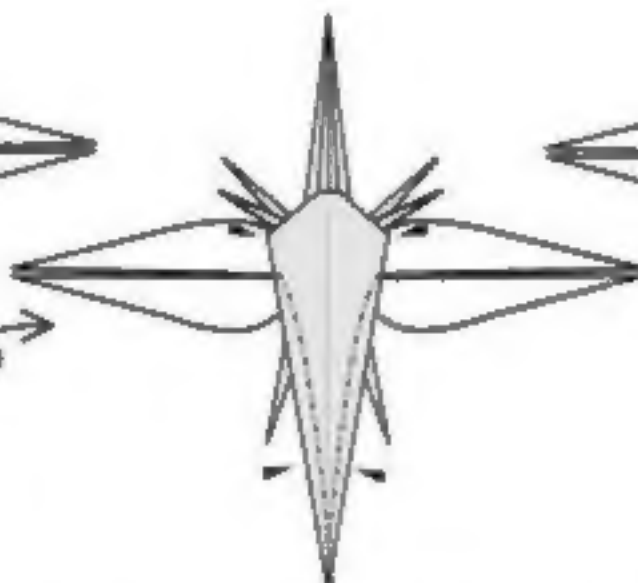
54. Tuck the little tabs underneath.



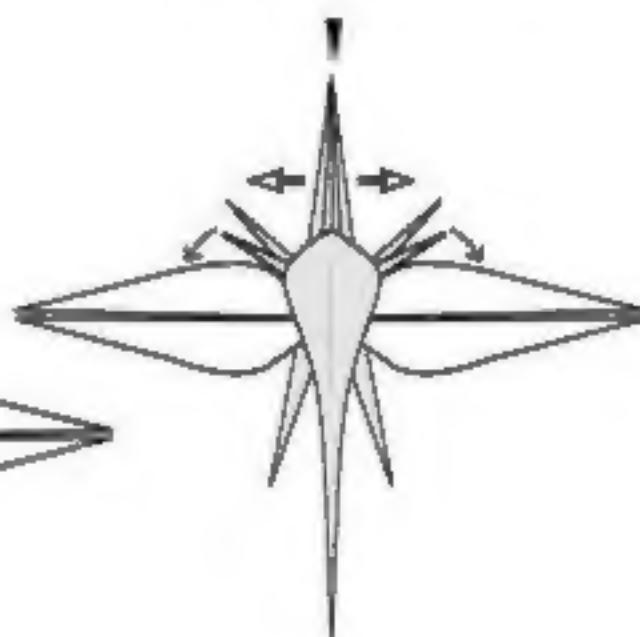
55. Pleat the structure to create the rear legs. Start with the outermost set and work your way in, compressing the body as you go.



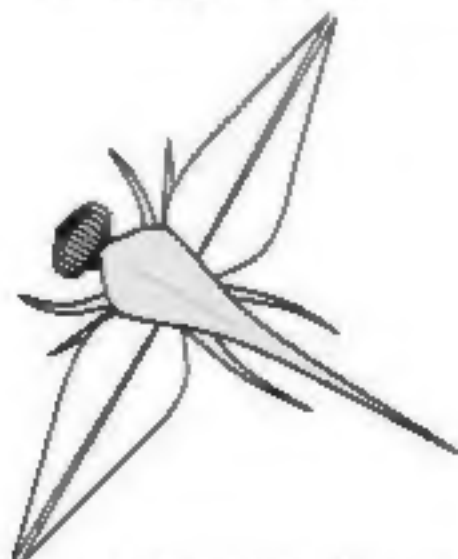
56. Like this (approximately). Turn the model over.



57. Thin the tail again and mold the model into final shape by compressing and rounding the body area and thinning and rounding out the tail.



58. Form the head by opening up the spine at the top while pinching at the base. Curl the legs slightly and the model is complete.



59. Completed model. Additional sculpting may be added at the folder's option.